

**THE PRESIDENT'S  
NATIONAL SECURITY TELECOMMUNICATIONS  
ADVISORY COMMITTEE**



***TRANSPORTATION INFORMATION  
INFRASTRUCTURE RISK ASSESSMENT  
REPORT***

**JUNE 1999**

**TRANSPORTATION INFORMATION INFRASTRUCTURE  
RISK ASSESSMENT REPORT  
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## **EXECUTIVE SUMMARY**

This document represents the culmination of a 2-year effort by the Information Infrastructure Group (IIG) of the President's National Security Telecommunications Advisory Committee (NSTAC) to study the information-based risks to the United States transportation information infrastructure. That infrastructure includes those information systems and computer networks that support the movement of people, goods, and services. This document describes the findings, conclusions, and recommendations derived from numerous presentations from industry experts, discussions with 12 transportation industry associations, and two NSTAC-sponsored conferences with transportation industry representatives.

The transportation infrastructure is one of the most diverse and complex in the United States. By any measure, it is critical to the Nation's security posture and economic competitiveness. While information technology (IT) is often cited as the catalyst for "globalization," transportation plays an equally important role, due to the emphasis on moving people, goods, and services in the most efficient and timely manner. To achieve this objective, the transportation industry has embraced the widespread use of information technology and adopted an intermodal approach. While beneficial from an economic and competitiveness perspective, the introduction of information technology and intermodal techniques also exposes the industry to new, often unforeseen risks.

### **Analysis**

Several factors are compelling the transportation infrastructure to become more efficient and to offer new services and capabilities tailored to the needs of its customer base. Information technologies are an indispensable component of the day-to-day business operations of the companies that compose the transportation infrastructure. Increased application of new and existing information technologies allows those companies to navigate vessels more effectively, track cargo shipments with greater accuracy, and facilitate electronic commerce transactions for their customers. Similarly, the ability of transportation companies and port facilities to incorporate intermodal capabilities into their existing operations offers new efficiencies in the transport of both passengers and cargo. Information technologies have enabled the services offered by transportation companies to expand from the task-specific movement of passengers and freight to include sophisticated just-in-time inventory strategies and supply chain management.

These new capabilities, however, also expose the transportation information infrastructure to new risks. This study found that emerging electronic threats to the infrastructure are not well understood and are outpacing deterrents. At the same time, customer demands are requiring a growing utilization of IT throughout the transportation industry. This trend is introducing new vulnerabilities into the transportation information infrastructure without complete industry understanding about the need for robust, active protection measures and strategies.

## **Conclusions**

Through its analysis of the risks to the transportation information infrastructure, the IIG reached the following conclusions:

- The transportation industry is increasingly reliant on IT and public networks.
- Although a nationwide disruption of the transportation infrastructure is unlikely, even a local or regional disruption could have a significant impact.
- Business pressures and widespread utilization of IT make large-scale, multimodal disruptions more likely in the future.
- A need exists for a broad-based infrastructure assurance awareness program to assist all modes of transportation.
- The transportation industry could leverage ongoing research and development (R&D) initiatives to improve the security of the transportation information infrastructure.
- Closer coordination is required between the transportation industry and other critical infrastructures.

## **NSTAC Recommendations to the President**

- Recommend that the President continue support for the efforts of the Department of Transportation (DOT) to promote outreach and awareness within the transportation infrastructure as expressed in Presidential Decision Directive 63 (PDD-63). Specifically, recommend that the President and the Administration ensure support for the following activities:
  - timely dissemination of Government information on physical and cyber threats to the transportation industry,
  - Government research and development programs to design infrastructure assurance tools and techniques to counter emerging cyber threats to the transportation information infrastructure,
  - joint industry/Government efforts to examine emerging industry-wide vulnerabilities such as those related to the Global Positioning System, and
  - future DOT conferences to stimulate intermodal and, where appropriate, inter-infrastructure information exchange on threats, vulnerabilities, and best practices.

## **1.0 INTRODUCTION**

Over the past decade, the President's National Security Telecommunications Advisory Committee (NSTAC) has been studying information-based risks to critical infrastructures within the telecommunications, electric power, and financial services industries. This study documents the findings and recommendations of the NSTAC's Information Infrastructure Group (IIG) derived from efforts to raise awareness in the transportation industry regarding its increasing reliance on information technology (IT) and the associated vulnerabilities. In December 1996, the IIG formed the Transportation Subgroup to study the information-based risks to the transportation infrastructure. Recognizing the complexity and diversity of the transportation industry, the IIG has worked with representatives from that industry, industry associations, the President's Commission on Critical Infrastructure Protection (PCCIP), and the U.S. Department of Transportation (DOT) in completing this study. This report does not necessarily reflect the official views of the Department of Transportation or the transportation industry contributors but rather the independent findings and recommendations developed by the IIG.

### **1.1 Background**

In January 1995, the Director of the National Security Agency (NSA) briefed the President's NSTAC on threats to U.S. information systems and the need to improve the security of critical national infrastructures. Reflecting on that information, NSTAC principals discussed emerging threats to information systems and subsequently forwarded a correspondence on that subject to President Clinton in March of that year. It stated that "[the] integrity of the Nation's information systems, both government and public, are increasingly at risk to intrusion and attack ... other national infrastructures ... [such as] finance, air traffic control, power, etc., also depend on reliable and secure information systems, and could be at risk." President Clinton replied to the NSTAC correspondence in July 1995, stating that he would "welcome NSTAC's continuing efforts to work with the Administration to counter threats to our Nation's information and telecommunications systems." The President further asked the NSTAC principals, with "input from the full range of national information infrastructure users," to assess the NS/EP requirements for the Nation's rapidly evolving information infrastructure.

#### **Figure 1. The President's NSTAC**

The NSTAC is a Presidential advisory committee established in 1982 to advise the President on national security and emergency preparedness (NS/EP) telecommunications issues. The NSTAC is composed of up to 30 senior corporate executives (often CEOs) from telecommunications, information system, and computer companies. The NSTAC principals designate subject matter experts to subordinate groups to examine national telecommunications and security issues.

In May 1995, the NSTAC formed the Information Assurance Task Force to work with the U.S. Government to identify critical national infrastructures and define their importance to the

national interest. Meetings with representatives from the national security community, law enforcement, civil departments and agencies, and the private sector, led the task force to determine that electric power, financial services, and transportation were some of the most critical infrastructures. The task force agreed to study these infrastructures to assess the extent to which their dependence on information and information systems places them at increased risk to denial-of-service attacks.

Building on the methodology developed by the Government and NSTAC Network Security Information Exchanges (NSIE) to assess the security risks to public networks, the Information Assurance Task Force scheduled three separate studies. The risk assessments of the electric power and financial services Infrastructures were completed in March 1997 and December 1997 respectively.<sup>1</sup> During the development of the Financial Services Infrastructure Risk Assessment, the NSTAC coordinated its activities with the recently established PCCIP, which was conducting a related study of the threats and vulnerabilities to the banking and financial services community.

In December 1996, the NSTAC launched efforts to study risks to the transportation information infrastructure. The IIG members (the successor organization to the Information Assurance Task Force) met with officials from industry and Government in a variety of forums. In addition, efforts to examine transportation industry issues were coordinated with the PCCIP and DOT, which were investigating transportation infrastructure threats and vulnerabilities. To fully address an infrastructure of the size and scope of transportation, the IIG used a phased approach that is described in greater detail below.

### **1.2 Purpose**

The purpose of the Transportation Information Infrastructure Risk Assessment is to independently assess the risk of information-based attacks on the transportation infrastructure and its information systems that could cause significant regional or national degradation or stoppage of the efficient movement of passengers or cargo. Specifically, the IIG identified the following objectives for this activity:

- study the security of the transportation information infrastructure at the national level relative to the identified (i.e., known or experienced) threats to its information systems and networks,
- identify trends regarding the transportation industry's growing use of information systems and networks,

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<sup>1</sup> Copies of the reports can be accessed via the World Wide Web at [www.ncs.gov](http://www.ncs.gov) or obtained from the Office of the Manager, National Communications System, Customer Service and Information Assurance Division, 701 S. Courthouse Road, Arlington, VA, 22204-2198.



- identify risks to the transportation industry that derive from its dependence on information technology and public networks,
- raise awareness in the transportation industry about information assurance threats and critical infrastructure interdependencies, and
- develop a working relationship between the transportation industry and the industries that compose other critical infrastructures.

### **1.3 Approach**

The transportation infrastructure represents one of the most technologically complex, diverse, and geographically dispersed sectors in the national economy. In many ways, each mode of transportation (e.g., air, rail, surface, maritime transport) is an infrastructure unto itself. While the modes are structured differently and often maintain their own infrastructure components, competitive business pressures and other industry trends are creating new interdependencies among the modes. To conduct a study that accurately reflects these factors, the subgroup used a phased approach to collect and analyze data. Specifically, the IIG took the following steps:

- received presentations from industry experts, industry associations, DOT, Federal Aviation Administration (FAA), PCCIP, and other experts on transportation industry threats, vulnerabilities, and trends (December 1996 – May 1997),
- sponsored a September 10, 1997, Transportation Information Infrastructure Risk Assessment Workshop at U.S. Army Reserve Command, Ft. McPherson, Atlanta, Georgia,
- produced an Interim Transportation Information Infrastructure Risk Assessment Report to the President (December 1997),
- conducted extensive research on transportation industry structure and trends to prepare for future outreach activities (January 1998 – August 1998),
- conducted a comprehensive outreach program in conjunction with DOT that involved briefing 12 industry associations representing all transportation modes on emerging information assurance threats, vulnerabilities, and infrastructure interdependencies (August 1998 – January 1999), and
- sponsored a second Transportation Information Infrastructure Risk Assessment Workshop on March 3 – 4, 1999 at the GTE Conference Facility in Tampa, Florida.

To promote industry awareness, the IIG invited representatives from DOT and the Federal Bureau of Investigation (FBI) to present at both conferences on emerging threats and infrastructure vulnerabilities. In addition, NSTAC and DOT presentations at the March 1999 conference and the individual sessions with industry associations emphasized the importance of Presidential Decision Directive 63 (PDD-63). That directive designated the DOT as the Lead Agency for coordinating with the transportation industry to eliminate significant infrastructure vulnerabilities. The NSTAC, through the IIG, is actively engaging senior Administration officials as PDD-63 and other Federal infrastructure assurance initiatives are implemented.

### **1.4 Analysis**

This study documents the findings and recommendations of the IIG derived from its analysis of information from all noted sources. The IIG paid special attention to collecting information from both industry and Government and across all modes of transportation. All relevant data and information collected from briefings, meetings, and the two industry conferences were analyzed on a **nonattribution** basis by the IIG members and representatives from the National Communications System.

### **1.5 Acknowledgments**

The IIG and its members would like to convey their appreciation to those NSTAC member companies, transportation industry representatives, and Government officials who participated in the conferences and contributed to this study. (Appendix A lists the members and regular contributors to the IIG's transportation activities. Appendix B provides copies of the conference agendas from the two NSTAC Transportation Information Infrastructure Risk Assessment Workshops.)

## **2.0 OVERVIEW OF THE TRANSPORTATION INDUSTRY**

The transportation industry is one of the most diversified and complex in the United States. By any measure, it is a critical infrastructure that supports the Nation's security posture, promotes national competitiveness, and improves the quality of life for all Americans. The companies composing the U.S. transportation industry move more goods and people than any other system in the world. The industry consists of millions of vehicles, operates on a physical infrastructure that could circle the globe more than 150 times, and employs 7 percent of the domestic workforce.<sup>2</sup> In 1996, the U.S. transportation industry system supported 4.4 trillion miles of passenger travel and 3.7 trillion ton miles of goods movement.<sup>3</sup> The transportation infrastructure continues to grow rapidly — between 1970 and 1995 passenger travel nearly doubled, and freight activity increased by 65 percent.<sup>4</sup>

The transportation industry is vital to the competitiveness of the U.S. economy and all of its industrial and technology sectors. While information technology is often cited as the catalyst for “globalization,” transportation plays an equally important role. In a business environment characterized by the drive to be “the first to market” with an imperative to reduce overhead costs and inventories, cost-efficient transportation is a key source of competitive advantage.

The burgeoning use of electronic commerce (EC) is also shaping the transportation industry's competitive environment. A growing number of private and public entities are expecting EC to improve their efficiency within this competitive environment. EC has encouraged a change in the way organizations approach logistics. EC allows organizations to move from a “just-in-case” logistics approach, where components are stored just in case they are needed, to a “just-in-time” approach, where components arrive at their destination coincidentally with the anticipated need. This change in logistics places an increased burden on the transportation infrastructure.

The transportation industry is often thought of in terms of modes — specifically, the means by which its various modes support the movement of both passengers and freight; although the separation of the freight industry from the passenger industry is usually well defined. The modes work individually and in concert to form the transportation infrastructure (see Figure 2).

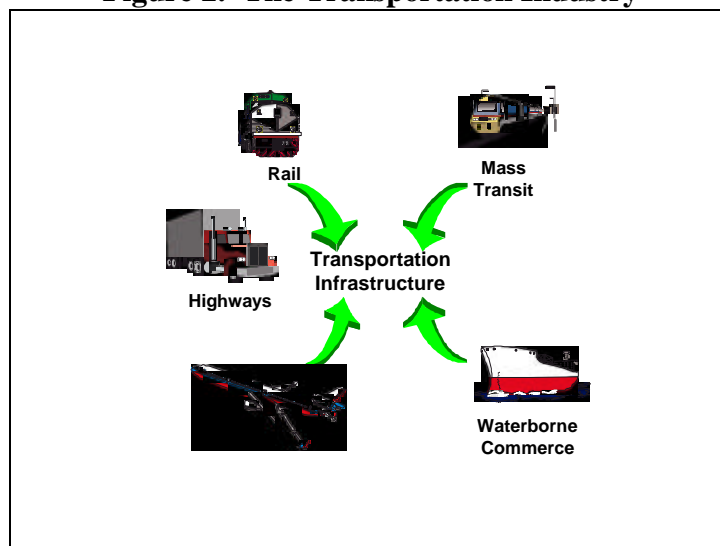
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<sup>2</sup> United States Department of Transportation, Bureau of Transportation Statistics, *Transportation in the United States, A Review*, Washington, DC, 1997.

<sup>3</sup> United States Department of Transportation, Bureau of Transportation Statistics, *Pocket Guide to Transportation*. Washington, DC, 1998.

<sup>4</sup> Ibid.

**Figure 2. The Transportation Industry**



The remainder of this section describes these modes of transportation in detail.

## **2.1 Airlines**

The U.S. airline industry, a diverse sector, has changed significantly over the past two decades following deregulation. Airline transportation typically covers large distances in relatively short, high-speed trips. First used widely in the 1960s following the advent of the jet airplane in the 1950s, the airline industry in the United States has been a mass-market service since deregulation in 1978. Over the past three decades, the airline industry has grown, with the number of air carrier vehicles increasing from 2,690 in 1970 to 5,961 in 1996.<sup>5</sup> In categorizing the airline industry, two separate and distinct sectors emerge: passenger airlines and freight airlines.

### **2.1.1 Passenger Airlines**

Passenger travel in the United States accounts for 73 percent of revenue generated from air transportation. Although airlines traditionally derive most of their revenue from business customers, the lower fares that followed deregulation have enabled a growing number of leisure travelers to take advantage of airline travel. In 1997, airlines carried approximately 598.9 million revenue passengers, a three percent increase from the previous year.<sup>6</sup>

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<sup>5</sup> Ibid.

<sup>6</sup> Air Transport Association, *ATA Annual Report*, Washington, DC, 1998.

The U.S. Department of Transportation (DOT) classifies air carriers by revenue size. Ten “major” carriers dominate the industry, with revenues exceeding \$1 billion. Figure 3 defines those major carriers in terms of passengers carried per year<sup>7</sup>:

**Figure 3. Major Air Carriers**

<b>Carrier</b>	<b>Passengers Carried in Thousands (1996)</b>
Delta Air Lines	97,201
United Airlines Corp.	81,863
American (Airline Group)	79,324
US Airways	56,639
Southwest Airlines	55,372
Northwest Airlines Inc.	52,682
Continental Airlines	35,743
Trans World Airlines	23,281
America West Airlines	18,130
Alaska Airlines	11,758

Total operating revenue for these major carriers does not issue from passenger transport alone. All of the major passenger airlines have significantly enhanced their total operating revenue by offering cargo transport services.

### ***2.1.2 Freight Airlines***

The demand for air freight service has grown faster than the demand for passenger service in recent years.<sup>8</sup> Major aircraft and airframe manufacturers expect a cargo growth rate of 6 percent to 8 percent for the next two decades,<sup>9</sup> which is 1 to 2 percent higher than the passenger transportation growth projection.<sup>10</sup> Seven freight-only carriers operate with revenues above \$20 million. Federal Express (FedEx) is the largest of those companies with a fleet of roughly 500 aircraft. Other prominent cargo carriers include the United States Postal Service, United Parcel Service (UPS) and DHL Worldwide Express. Smaller, independent companies operate contracted services with larger freight carriers. Figure 4 details the major cargo airlines in terms of total freight ton miles.<sup>11</sup>

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<sup>7</sup> Ibid., ATA, 1997.

<sup>8</sup> Robert V. Dahl “Air Freight Market is Expanding,” *Aviation Week & Space Technology*, January 13, 1997.

<sup>9</sup> Ibid.

<sup>10</sup> Ibid.

<sup>11</sup> Air Transport Association, op. cit.

**Figure 4. Major Air Freight Carriers**

<b>Airline</b>	<b>Freight Ton Miles In Thousands (1996)</b>
Federal Express	5,353,490
United Parcel Service	3,351,121
Northwest	1,910,689
United	1,785,759
American	1,641,172
Delta	1,000,133
Emery	965,205
Polar Air	769,342
Evergreen	451,248
Continental	359,142

The “feeder and distribution” services are composed of small, independent cargo operators that are contracted to larger cargo carriers. These small cargo airlines enable businesses and consumers to reach remote areas across the United States. To accomplish this, a majority of freight airlines function as multimodal transportation companies, combining their air transport assets with trucking fleets to enable them to reach more customers in a timely fashion.

## **2.2 Railroads**

Historically, the railroad industry has provided a robust infrastructure for moving heavy freight and material large distances across the continental United States and Canada. For the past 30 years, the U.S. has been experiencing a major restructuring of its railroad industry. Following some financial setbacks in the 1970s, the Nation's rail system sought to increase its profitability by raising revenues, improving efficiency, and reducing costs. The removal of Government price controls and regulations in 1980, coupled with consolidations among the major U.S. freight railroads, helped facilitate an expansion in freight volume and renewed investment for the industry's modernization. In addition, rail shipping rates have fallen significantly, as service levels have consistently improved, making rail transportation a more attractive option to business customers. However, railroad usage for passenger travel remains less economically efficient.

### **2.2.1 Passenger Railroads**

The automobile and a greatly improved U.S. public highway system made many passenger rail routes unprofitable. More recently, the demand for passenger rail service has suffered from the increase in low-fare airlines that provide faster service and often undercut the prices of Amtrak. Amtrak was created by the Rail Passenger Service Act of 1970 to revitalize intercity passenger rail service and relieve railroads of money-losing passenger trains. Amtrak trains and connecting Thruway Motorcoaches serve more than 500 communities in 45 States. An additional 48 million

customers use commuter service operated by Amtrak under contract for regional transportation authorities. Through fiscal year 1998, the Federal Government has provided Amtrak with more than \$20 billion in operating and capital subsidies, excluding \$2.2 billion from the Taxpayer Relief Act.<sup>12</sup>

Although only one of Amtrak's 40 routes (Metroliners between Washington, DC, and New York City) can currently cover its operating costs, decisions to discontinue service along its lower-performing routes may not be a particularly viable option. The reason is that Amtrak is likely to encounter opposition from the communities affected by the route discontinuations. In addition, halting service on less profitable routes could exacerbate Amtrak's financial woes by affecting ridership on connecting routes that may be performing better.<sup>13</sup>

Despite its financial concerns, Amtrak has pursued the most successful high-speed rail initiatives to date. With Congress agreeing to fund capital improvements for the Northeast Corridor improvement program, plans have been made for Amtrak to operate reliable, high-speed rail passenger service.<sup>14</sup>

### ***2.2.2 Freight Railroads***

Freight shipping is the dominant business of U.S. railroads, accounting for 96 percent of total industry revenues in 1996.<sup>15</sup> Figure 5 depicts the general characterization of freight railroads. Railroads have restructured operations and increased revenue significantly, mostly through mergers, economic growth, improved pricing strategies and an overall increase in efficiency and productivity. These actions have allowed railroads to reduce costs and compete effectively with intercity trucking firms, bargelines and even ocean shipping in some cases. Experts predict that the strong demand for intermodal transport and the industry's continued economic growth are likely to push railroad freight revenues up by 13 percent (\$39.0 billion) by 2001.<sup>16</sup>

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<sup>12</sup> Phyllis F. Scheinberg, Associate Director, Transportation Issues, Resources, Community and Economic Development Division, General Accounting Office, *Testimony Before the Subcommittee on Transportation, Committee on Appropriations*, U.S. Senate. March 24, 1998.

<sup>13</sup> Ibid.

<sup>14</sup> These plans include electrification of the New Haven-to-Boston stretch of the Northeast Corridor route, scheduled to begin service between Washington, New York, and Boston by November 1999.

<sup>15</sup> Euromonitor, *U.S. Railroads*, op. cit.

<sup>16</sup> Ibid.

**Figure 5. Characterization of Freight Railroads**

<b>Classifications</b>	<b>Description</b>	<b>Examples of Companies</b>
Class I	Railroads with operating revenue of \$255.9 million or more.	Burlington Northern/Santa Fe, CSX, Kansas City Southern, Norfolk Southern, Illinois Central, Union Pacific
Regional	Railroads earning revenue between \$40 million and \$255.8 million and/or operating at least 350 miles of track.	Florida East-Coast Railway, Montana Rail Link, Wisconsin Central
Short Line (Local)	Railroads falling below the criteria for a regional line, including switching and terminal railroads.	Ann Arbor Railroad, Blue Mountain Railroad, East Jersey Railroad & Terminal Co.

The coal industry is the primary user of rail because of the long distances between most coal mines and the power plants that use the coal. The coal industry generates approximately 22 percent of revenue for the rail industry.<sup>17</sup> Coal continues to be a profitable cargo because it moves in single-unit trains that are easy to load and transport as needed. A look at the primary types of rail cargo, including coal, shows that the rail industry is used for the intercity transport of items crucial to the economic stability and national security of the United States, as indicated by Figure 6.<sup>18</sup>

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<sup>17</sup> Association of American Railroads, *Railroad Facts 1998*, Washington, DC, 1997.

<sup>18</sup> Association of American Railroads website ([www.aar.com](http://www.aar.com)).



**Figure 6. Percentage of Key Products Moved by Rail**

Item	Percentage of Total Carried by Railroads
Motor Vehicles and Parts	70%
Coal	65%
Pulp and Paper	50%
Farm Products	49%
Chemicals	40%
Food	40%

As Figure 5 shows, in addition to the Class I rail carriers, more than 500 railroad companies operate as regional or short-line railroads. These companies account for about one-third of all rail route miles, employ roughly 11 percent of all rail workers, and generate about 9 percent of all rail revenue. The emergence of the smaller, regional railroads can be attributed to the deregulation of the rail industry in the 1980s, because deregulation permitted entrepreneurs to buy portions of rail line. As Class I railroads streamlined their systems and operations by selling large sections of rail, shorter rail lines grew by purchasing the excess track.<sup>19</sup>

### **2.3 Highways**

As the most common methods of passenger travel and freight shipment, personal highway travel and trucking over the U.S. highway system continue to constitute the largest portion of transportation mileage. Highway passenger miles vastly outnumber the passenger miles for all other modes combined.<sup>20</sup> Similarly, trucking constitutes the largest portion of mileage for freight transport.

The National Highway System includes 44,000 miles of interstate highways and over half of all the Nation's principal arterial roads. DOT is committed to design a program to focus Federal attention and resources on highways that are important for the national welfare. States have spent National Highway funds on projects that add capacity or develop new routes. For example, 55 percent of all National Highway System obligations are for projects that add capacity. In addition, according to the Federal Highway Administration, the percentage of mileage in poor condition on urban interstates declined from 16.8 percent in 1983 to 7.7 percent in 1991. On rural interstates, the percentage of miles in poor condition declined from 13.3 percent in 1983 to 7.6 percent in 1991. The Federal Highway Administration estimates that

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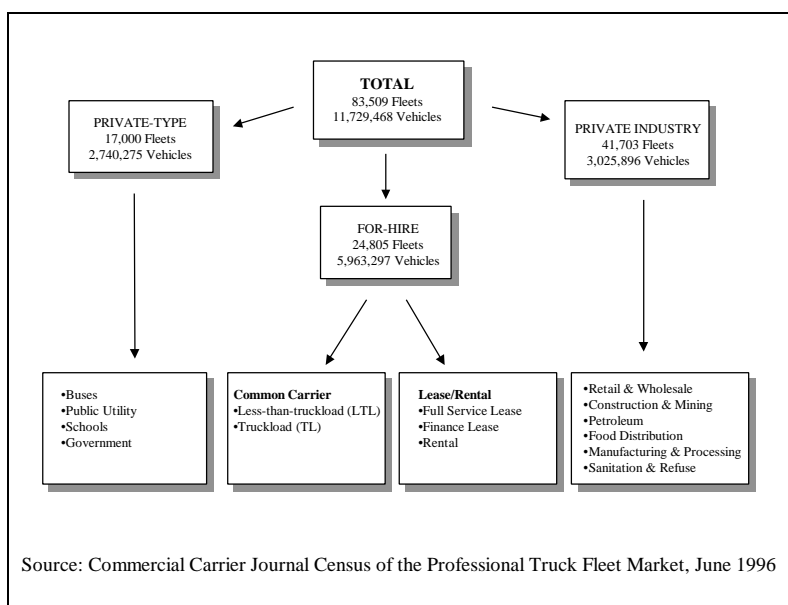
<sup>19</sup> American Short Line and Regional Railroad Association website ([www.aslrra](http://www.aslrra)).

<sup>20</sup> U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics 1998*, Washington, DC, 1998.

another \$8.5 billion a year will be required to build new roads to accommodate metropolitan expansion.<sup>21</sup>

The primary commercial user of the National Highway System is the trucking industry, which transports 78 percent of the United States commercial freight market, making it the preferred method for freight cargo in the United States.<sup>22</sup> Trucks tend to move freight over shorter distances than other transportation modes. The cargo usually includes high-value manufactured products instead of bulk raw products moved by rail, barge, and pipeline. Trucking fleets are normally classified as being in one of three categories: private industry, private-type, and for-hire. Private industry fleets operate within corporations whose primary business is not trucking. Often such an arrangement can help a company to more efficiently distribute a product or keep closer contact with customers. Similarly, private-type fleets operate as a part of a public entity, such as a school or government, for general benefit. For-hire trucking fleets operate as independent corporations whose primary business is to haul freight within a certain geographic area or over specific routes. Figure 7 depicts these trucking industry components.

**Figure 7. Trucking Industry Components**



The common carrier category of for-hire trucking is the largest component of the entire trucking industry in terms of number of vehicles. Common carrier fleets offer differing services according to the nature of delivery and the freight being hauled. The categories are called

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<sup>21</sup> Surface Transportation Policy Project, *The False Crisis of America's Crumbling Roads and Bridges And Why Special Interest Highway Lobbyists Like It That Way*, October 1996.

<sup>22</sup> U.S. Department of Commerce, International Trade Administration, *U.S. Industry and Trade Outlook 1998*. New York: DRI/McGraw Hill, 1997.

“truckload” (TL) and “less-than-truckload” (LTL). TL carriers, which compose the largest portion, transport larger shipments of goods from origination point to destination with no intermediate stops. LTL carriers use the “hub and spoke” method to consolidate many shipments from numerous customers before transporting them to a variety of destinations. TL carriers, which generate a larger portion of trucking industry revenue than LTL carriers, tend to be smaller companies specializing in truckload hauls measuring less than 500 miles. The large number of companies operating in the TL market is a result of industry deregulation in 1980 and the low entry costs derived from less intermediate handling.

On the other hand, LTL carriers face numerous market-entry costs, such as the costs of road equipment, computer systems, and intermediate handling. Because of these high front-end investment requirements, larger, well-financed individual companies are more likely to thrive in the LTL market in which regional carriers provide specialized service in a given region. The high cost of service for LTLs is expected to grow as the demand for just-in-time delivery of inventory stock continues, requiring increases in shipments and improved tracking technology. The trucking industry as a whole faces higher costs for labor and fuel; and to maximize already slim profit margins, increasingly relies on technological innovations to shorten delivery times and improve service. The reliance on new technologies is radically altering the trucking industry in ways that are discussed at length in Section 3 of this report.

## **2.4 Ports, Waterways, and Marine Shipping**

The oldest and most common method of mass cargo transportation is water shipping. Water shipping operates on a macro level, where cargo is brought to one of the nearly 100 seaports of the United States and then is transferred to other intermodal modes of transportation, such as trucking and rail, for delivery to the final destinations. The U.S. public port industry consists of more than 100 public port authorities and agencies located along the Atlantic, Pacific, and Gulf coasts, along the Great Lakes, as well as in Alaska, Hawaii, Puerto Rico, Guam, and the U.S. Virgin Islands.<sup>23</sup>

Oceanic and international shipping is the largest component of water transportation and is increasing because of expanded U.S. trade with Asia, Europe, and Latin America. Currently, U.S. deep draft ports accommodate ocean-going vessels that move over 95 percent of U.S. trade by weight and 75 percent by value.<sup>24</sup> Ocean shipping is likely to remain a critical component in the Nation's overall transportation infrastructure, as U.S. Customs estimates that the volume of imported cargo moving through U.S. ports will triple by 2020.

U.S. waterways, ports, and their intermodal connections are the essential elements of marine transportation. Port authorities are finding an increasing need to be prepared for and respond to the pressures of growing trade, more noncommercial waterway users, the development of new

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<sup>23</sup> American Association of Port Authorities website ([www.aapa-ports.org](http://www.aapa-ports.org)).

<sup>24</sup> United States Bureau of the Census.

means to harvest and preserve marine resources, and increasingly aggressive efforts by criminals and adversaries intent on stealing cargo.

Hundreds of companies, ranging from large carriers having thousands of ships to small family-owned operations, transport goods to U.S. ports and along U.S. waterways. Carriers can range from large mega-vessels (3,000 – 6,000 twenty-foot equivalent units [TEU]) to mid-size ships (2,000 – 3,000 TEU) to smaller carriers. Additionally, these companies can be defined as either vessel operating common carriers (VOCC), which operate their own ships, or non-vessel operating common carriers, which transport goods for payment but do not operate their own ships. The major VOCCs include the following:

- CSX Corporation—Sea-Land Service subsidiary,
- Archer Daniels Midland,
- Eastern Enterprises, and
- Ingram Barge Company.

Carriers transport a variety of cargo, which can be packaged as bundles, crates, barrels, or pallets; liquid bulk cargo like petroleum; dry bulk cargo such as grain; and general cargo in steel boxes called containers, measured in TEUs.<sup>25</sup> Types of cargo shipped for domestic and foreign trade through U.S. ports include —

- automobiles, automobile parts, and machinery,
- clothing, shoes, electronics, toys,
- crude petroleum and petroleum products — oil, gasoline,
- chemicals and related products — fertilizer,
- coal — bituminous, metallurgical, steam,
- food and farm products — wheat and wheat flour, corn, soybeans, rice, cotton, coffee,
- forest products — lumber, wood chips,
- iron and steel, and
- soil, sand, gravel, rock, and stone.<sup>26</sup>

The flow of international container traffic through U.S. ports is highly concentrated. In 1995, the 25 leading container ports accounted for roughly 98 percent of container traffic moving in U.S. foreign trade.<sup>27</sup> The major ports in the United States, measured by millions of dollars in both imports and exports, are represented in Figures 8 and 9.<sup>28</sup>

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<sup>25</sup> The trend toward containerization is discussed further in section 3.3.1 of this report.

<sup>26</sup> American Association of Port Authorities, op. cit.

<sup>27</sup> U.S. Department of Commerce, International Trade Administration, op. cit.

<sup>28</sup> Compass North America, Incorporated, website ([www.seaportsinfo.com](http://www.seaportsinfo.com)).

**Figure 8. Leading U.S. Ports (Import)**

<b>Port</b>	<b>Millions of U.S. Dollars in Imports (1997)</b>
Long Beach	65,529
Los Angeles	57,725
New York	47,392
Seattle	23,300
Houston	16,230
Oakland	15,440
Charleston	15,168
Tacoma	15,104
Baltimore	11,682
Norfolk	11,185

**Figure 9. Leading U.S. Ports (Export)**

<b>Port</b>	<b>Millions of U.S. Dollars in Exports (1997)</b>
Houston	20,808
New York	20,638
Long Beach	19,088
Los Angeles	16,116
Norfolk	14,178
Charleston	11,714
Seattle	10,305
Oakland	9,875
New Orleans	9,351
Miami	8,456

Additionally, the U.S. barge and towing industry plays an important role in the U.S. transportation system. Significant percentages of products bound for export or imported from other nations are transported to other countries or U.S. consumers via inland and coastal shipping. The shipping routes along inland and coastal areas are plied by 6,200 tug and towboats and more than 30,000 barges, moving 15 percent of the Nation's freight for less than 2 percent of the Nation's total freight bill. Inland and coastal shipping also contributes more than \$5 billion a year to the Nation's economy.<sup>29</sup> The movement of commerce along these inland and coastal

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<sup>29</sup> American Waterways Operators website ([www.riibb.com](http://www.riibb.com)).

ports is also highly concentrated, with the 25 leading ports handling 70 percent of the waterborne trade in 1995.<sup>30</sup>

Barges operating along the Nation's 25,194 miles of inland and intracoastal waterways, including the Atlantic, Pacific, and Gulf coasts, transport 30 percent of the oil and petroleum products that are used for domestic and commercial purposes.<sup>31</sup> Twenty percent of the Nation's coal used annually moves by barge on U.S. inland waterways and coastal routes, as does nearly 800 million tons of raw materials and finished goods.<sup>32</sup>

## **2.5 Mass Transit**

Mass transit transportation, which includes bus, commuter rail, light rail, and ferryboats, accounts for only a small percentage of the passenger-miles traveled per year. Innovations in transit technology systems are being tested and implemented across the Nation. These technologies will be used to improve the dispatch, management, and communications systems used by metropolitan transit systems, as well as to facilitate passenger information and electronic fare-payment capabilities. Large transit systems are located mainly in urban areas. Figure 10 details the directional route-miles serviced by urban transit systems.<sup>33</sup>

**Figure 10. Directional Route-Miles Serviced by Urban Transit**

<b>Transit Mode</b>	<b>Directional Route-Miles Serviced</b>
Bus	158,310
Commuter Rail	3,682
Heavy Rail	1,478
Light Rail	638

In New York City, passenger miles exceed 10 billion per year. Other areas where the use of public transit is especially pervasive are San Francisco, Washington, DC, Chicago, Philadelphia, and Boston. Since transit operations generally are contained in a specific city, State, or region, the carriers for this mode do not operate national networks.

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<sup>30</sup> U.S. Department of Commerce, International Trade Administration, op. cit.

<sup>31</sup> American Waterways Operators, op. cit.

<sup>32</sup> American Waterways Operators, op. cit.

<sup>33</sup> U.S. Department of Transportation, Bureau of Transportation Statistics, *Transportation Statistics Annual Report 1998*. Washington, D.C., 1998.

### **3.0 INDUSTRY TRENDS**

The transportation infrastructure is undergoing several fundamental changes that are shaping the industry landscape. Deregulation, advancing technology, and the demands of the global marketplace have transformed the U.S. transportation industry from a task-specific component in the Nation's economy to a provider of logistical services and trade solutions.<sup>34</sup> This transformation has been driven by three developments: increased reliance on information technology, industry consolidation and globalization, and the emergence of intermodal transportation.

#### **3.1 Increased Reliance on Information Technology**

Like its counterparts in other sectors of the economy, the transportation industry is leveraging advances in information technologies to increase efficiency by automating and streamlining key business processes and reducing overhead. While generating substantial benefits for individual companies, the rapid introduction of information technology is also creating new industry-wide dependencies on navigational systems, shipment tracking technologies, and electronic commerce capabilities to accomplish day-to-day business operations. These dependencies are deepened by the transportation industry's efforts to—

- coordinate and integrate its critical nodes across modes,
- exploit the globalization of the U.S. transportation industry,
- develop intelligent transport systems, and
- support the rapid dispatch and transport of goods needed for just-in-time (JIT) inventory systems.

Issues involving information technology dependencies are likely to manifest as trends in three broad areas: navigational systems, cargo tracking systems, and electronic commerce. Each of these areas is discussed in detail below.

##### ***3.1.1 Navigational Systems Trends***

A variety of information technology and communications capabilities are being used or considered throughout the transportation industry for the purposes of navigation in both passenger and freight transportation. These technologies coordinate the safe and efficient transport of multiple vehicles, reducing the risk of accidents while also planning the quickest possible routes.

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<sup>34</sup> Bank of America, *Transportation: Fueling the Economic Expansion*, Chicago, 1997.

***3.1.1.1 Global Positioning Satellite System***

The Global Positioning Satellite (GPS) system, initiated by the Department of Defense (DOD) in 1973, is a satellite-based system used for a variety of commercial transportation applications. Using triangulation principles and land-based receivers, GPS provides high levels of accuracy in determining Earth positions. It is designed to use the known positions of satellites in space to determine unknown positions by users on land. It is a passive system that does not require information about the user or the user's receiver for a reading of the user's position.<sup>35</sup>

DOD maintains the system but allows one of the two signals transmitted by the 24 GPS (21 active and 3 spare)<sup>36</sup> satellites in orbit to be used for commercial applications. The Standard Positioning Service (SPS) is available to all users on a worldwide basis with no direct charge, and it provides accuracy of 100 meters horizontally and 156 meters vertically.<sup>37</sup> The SPS system was designed with a deliberate degradation that reduces its overall accuracy, which renders it ineffective for military use.<sup>38</sup> The Precise Positioning Service (PPS) is used for military positioning and available only to users authorized by the United States, and it provides accuracy of at least 22 meters horizontally and 27.7 meters vertically.<sup>39</sup>

GPS consists of 3 major segments: space, control, and user. The space segment includes 24 satellites; the control segment consists of 5 monitor stations around the world with 3 ground antennas and a master control station in Colorado; and the user segment consists of antennas and receiver-processors that feed positioning information to the user.<sup>40</sup>

The use of GPS as a tracking and guidance tool is one important commercial application being implemented by the transportation industry. For instance, the industry uses GPS to monitor shipments in crowded storage facilities and vehicles, thus improving delivery speed and accuracy. Integrators<sup>41</sup> and trucking companies that transport large volumes of cargo in short periods of time are most likely to take advantage of GPS. Satellite technology for vehicle tracking has been available since the early 1980s, but installation began only in 1987. The use of satellite technology enables trucking firms to locate trucks with greater precision by linking onboard computers with company dispatchers via satellites. Through the utilization of this technology, major trucking firms have achieved significantly higher on-time performance records.

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<sup>35</sup> John A. Kusters, "The Global Positioning System and HP SmartClock," *Hewlett-Packard Journal*, December 1996.

<sup>36</sup> Robert G Wilford, *Navigation and Mobile Telecommunication Technologies for European Road Freight Operations in the Late 1990s*, Illinois: Delft Press, 1996.

<sup>37</sup> U.S. Naval Observatory website (<http://tycho.usno.navy.mil>).

<sup>38</sup> Kusters, op. cit.

<sup>39</sup> U.S. Naval Observatory, op. cit.

<sup>40</sup> U.S. Naval Observatory, op. cit.

<sup>41</sup> Integrators are companies that typically offer door-to-door delivery of parcels and use information systems to track and trace cargo. Examples of integrators include DHL, Federal Express and United Parcel.



From a safety and logistics standpoint, GPS technologies can facilitate the development of long-awaited intelligent railroads, highways, and airways. In the transit mode, some of these applications are being tested as part of the Intelligent Transportation System (ITS) program to develop in-car traffic management systems and light-rail coordination applications. In aviation, government and industry are developing GPS-based systems to improve in-flight navigation systems, all-weather landing systems, and airport traffic surveillance. The pilot system developed to accomplish these goals, known as the Wide Area Augmentation System, or WAAS, is being tested by the FAA.

### *3.1.1.2 Airline Navigation Systems*

The growing use of information technology in the airline industry has led to developmental programs geared toward increasing safety, airline efficiency, and the capabilities of the Nation's Air Traffic Control (ATC) System. GPS and Free Flight/Flight 2000 are two technologies involving telecommunications that are being considered to improve both passenger and freight airline transportation.

Free Flight—a network of air and ground communications systems, on-board computers, and GPS—is a new system of air traffic control management that will allow pilots to have more control of operating flexibilities throughout the National Airspace System (NAS).<sup>42</sup> A major component of Free Flight will be the Future Air Navigation System (FANS)<sup>43</sup> program, which uses emerging technologies to improve communications between pilots and controllers. Currently, pilots rely almost exclusively on air traffic controllers, who use a centralized command and control system to set routes.

Beginning in 2000, the FAA will proceed with plans for the first major test of Free Flight, dubbed Flight 2000. Flight 2000 will test the abilities of current and planned communications, navigation, and surveillance (CNS) systems to allow airlines the freedom and ability to plan and fly their own routes.<sup>44</sup> Concurrently, air traffic control is then expected to move to this more flexible system allowing pilots to alter their routes during flight. Even under Free Flight, however, the ultimate decision-making authority will still reside with air traffic controllers.<sup>45</sup>

Flight 2000 is expected to provide more precise positioning information on the location of aircraft. Use of this precise positioning information will assist in the safe and efficient operation of aircraft in busy airspace by enabling the aircraft to fly in closer proximity with reduced risk of collision.<sup>46</sup> Basically, the Free Flight network is designed to allow more aircraft to operate

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<sup>42</sup> "FAA Sets Course for Free Flight," *Aviation Week & Space Technology*, August 31, 1998.

<sup>43</sup> David Steigman, *Aviation Week and Space Technology: Aerospace Source Book*, New York: McGraw-Hill, 1999.

<sup>44</sup> *Ibid.*

<sup>45</sup> General Accounting Office, "National Airspace System: FAA Has Implemented Some Free Flight Initiatives, but Challenges Remain," GAO/RCED-98-246.

<sup>46</sup> *Ibid.*

simultaneously within the NAS. All Flight 2000 aircraft will carry enhanced CNS systems with an Automatic Dependent Surveillance Broadcast (ADSB) transponder that transmits the aircraft's position, heading, altitude, and speed to other aircraft and local ground stations.<sup>47</sup> ADSB broadcasts aircraft positions where radar does not reach. These new technologies will give controllers better information about location of aircraft, allowing potential problems to be diagnosed and resolved before operations are disrupted.<sup>48</sup>

Another provision for aircraft safety to be tested during Flight 2000 is the Traffic-alert and Collision Avoidance System (TCAS). TCAS provides traffic warnings and collision resolution advisories to pilots and controllers.<sup>49</sup> TCAS also supplies the pilot with traffic and resolution advisories, and recommends vertical escape maneuvers to avoid a possible collision.<sup>50</sup> The additional installation of an Enhanced Ground Proximity Warning System (EGPWS), which links GPS to a comprehensive database of terrain data, will further enhance the abilities of Free Flight and ease safety concerns in the airlines industry.<sup>51</sup> These developing technologies will give the pilots more time to prevent Controlled Flight Into Terrain (CFIT) and provide more terrain awareness.<sup>52</sup>

As with most new technologies, there are issues related to the safe application of these navigation systems. The FAA, along with various air associations, has expressed some concerns regarding Free Flight and GPS. For example, to maximize the benefits of Free Flight, some industry experts maintain that these new technologies must be coordinated and integrated on a global scale.<sup>53</sup> In addition, there are concerns regarding the vulnerabilities associated with GPS. In a report prepared by the General Accounting Office, concerns of the FAA, Air Transport Association (ATA), and the Aircraft Owners and Pilots Association (AOPA) were outlined regarding the vulnerability of an augmented satellite system to intentional and unintentional jamming. The report also noted that GPS, in its current form, lacks redundancy and may not be fully reliable, possibly leaving aircraft vulnerable to flying blind.<sup>54</sup> A further concern is whether GPS should be used as the sole means of navigation under Free Flight or as the primary means of navigation, whereby aircraft would likely be required to carry additional navigational equipment as backup.<sup>55</sup>

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<sup>47</sup> Steigman, op. cit.

<sup>48</sup> Ibid.

<sup>49</sup> Ibid.

<sup>50</sup> "Demand for Lower Aircraft Collision Risks Spurs Rapidly Growing TCAS and EGPWS Markets," *PR Newswire*, July 20, 1998

<sup>51</sup> Ibid.

<sup>52</sup> Ibid.

<sup>53</sup> GAO/RCED-98-246, op. cit.

<sup>54</sup> "FAA Orders GPS Risk Assessment," *Aviation Week & Space Technology*, August 3, 1998.

<sup>55</sup> GAO/RCED-98-246, op. cit.

***3.1.1.3 Freight Rail Navigation Systems***

Information technology also plays a crucial role in managing the traffic along the vast network of U.S. railroad lines. About one-half of the railroad tracks in the United States are controlled by signal systems in which train control is facilitated by the use of track circuits.<sup>56</sup> Approximately one-third of the tracks employing signal systems use centralized traffic control (CTC); one-sixth use automatic block signals (ABS); and less than one-twentieth use automatic train control (ATC). The tracks controlled by these systems carry over 80 percent of total railroad traffic.<sup>57</sup> The remaining half of railroad track in the U.S. is called “dark territory” because it has no signal systems or track circuits in place. Control over dark territory and ABS territory is by movement authorities (“track warrants”) issued by dispatchers over voice radio.<sup>58</sup> Railroad dispatchers operate CTC and ATC signaling systems with computers installed at control centers. These computers control the switches and signals on the third of the railroad track equipped with CTC or ATC systems.<sup>59</sup>

A current trend in railroad industry traffic management is the exploration of positive train control (PTC) systems to accomplish fundamental safety functions such as train separation. These systems, designed to operate with existing signal systems, facilitate collision-avoidance through the use of on-board computers. For example, in early 1998, the Nation's major freight railroads, represented by the American Association of Railroads, the Federal Railroad Administration (FRA), and the Illinois Department of Transportation, funded and provided support for PTC demonstration projects on segments of Union Pacific (UP) railroad lines in the State of Illinois. It was determined that this 4 year demonstration program would be a suitable starting point for national implementation of a PTC system, which would be used to support both freight service and high-speed passenger rail operations.

The Illinois projects are being considered on the national scale for their use of full PTC capabilities, which involve GPS to locate each train and its on-board computer, as well as the transmission of information from each train in the system to a control center. The control center will use central computers to coordinate operations and issue operating authorities over a digital radio network to each train.<sup>60</sup> Before a PTC system can be deployed nationwide, interoperability issues must be resolved, as various PTC technologies rely on wayside computers or on-board proximity warning technology, as opposed to a central dispatch office, for communications capabilities. The costs and benefits of PTC is also a matter of study, since the mobile, lineside and control systems require significant investment in hardware and system integration.

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<sup>56</sup> Donald M. Itzkoff, Deputy Administrator, Federal Railroad Administration, *Testimony Before the Committee on Transportation and Infrastructure*, United States House of Representatives. October 2, 1998.

<sup>57</sup> Ibid.

<sup>58</sup> Ibid.

<sup>59</sup> Ibid.

<sup>60</sup> United States Department of Transportation press release. February 13, 1998.

#### *3.1.1.4 Passenger Rail Navigation Systems*

Amtrak has also made use of newer information technologies, having recently installed an advanced satellite-based communications system on some of its long-distance trains. The mobile communications system enables Amtrak's operations department to maintain direct contact with its trains and allows it to monitor train locations and status. This direct contact is facilitated through a communications link connecting the messaging terminal in the locomotive of an Amtrak train, the remote terminal used by personnel in the passenger section of the train, and Amtrak's operations department. This instantaneous communications network allows Amtrak to respond to passenger needs and emergencies without delay.

#### *3.1.1.5 Truck Navigation Systems*

Information technology has become such a fundamental need in the trucking industry that 40 percent of TL drivers today travel with computers.<sup>61</sup> Technology is an integral part of the way trucking companies perform their administrative functions, monitor their fleets to meet laws and regulations, and implement innovative ways to maximize profits. Trucking companies employ a number of technologies to monitor their fleets, some of which rely on the Internet. These technologies offer numerous administrative advantages. Vehicle and freight tracking systems as well as information storage and exchange systems enable firms to increase productivity, and offer unique and efficient capabilities to their customer base. These systems employ information technologies and networks to record the progress of a freight shipment from origin to destination while satellite technology, in the form of GPS, provides information on the precise location of truck fleets. As previously noted, fleets utilizing satellite technology have a significantly higher on-time performance. This is a significant

#### **Figure 11. The Modern Trucker**

Schneider National trucking company in Green Bay, WI, places on-board computers in the cabs of its trucks. These computers are equipped with numerous technological features, one of which is GPS. Prior to the use of GPS technology and on-board computers, drivers had to telephone fleet managers to tell them the time and place of shipment deliveries. Thus, trucking companies had no control over their fleet and virtually no means of communication between its drivers and headquarters. Use of GPS has now given companies the ability to know where their trucks are at all times. At Schneider National, the trucks equipped with GPS are represented as dots moving on computerized maps, providing headquarters with a variety of monitoring and dispatching capabilities. For example, dispatchers can use GPS to reroute trucks to maximize shipment pick-up and delivery and to help facilitate just-in-time inventories. GPS can also be used to monitor a driver's speed, direction, and determine whether he or she followed Federal rules for maximum hours worked.

Sources: Schneider National website ([www.schneider.com](http://www.schneider.com))  
New York Times, March 4, 1999.

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<sup>61</sup> "Web Keeps on Rolling for Truckers," *Internet Week*, December 7, 1998.

motivation for the industry to move away from the older system of tracking fleet movement with paper logs and telephone check-ins.<sup>62</sup>

On-board computers or single board computers (SBC) record the performance of the driver and the vehicle. These SBCs are small, powerful computers that connect directly to a wide variety of input sensors and output devices and offer a variety of networking capabilities. SBCs are compact and able to withstand demanding environments.<sup>63</sup> Eventually, on-board computers will provide real-time performance data that will provide feedback to the driver on routes, engine diagnostics, and other vital information. Interactive screens are also being introduced to allow drivers to enter information on change of duty status, wait time, departure/arrival time and state-line crossings. Recent advances in software enable business information to be included in the recorded data, such as customer names, cargo lists, and bar codes. A communications system can be added, enabling data to be passed back and forth in real-time, allowing the driver and dispatcher to react to changing situations almost instantaneously.<sup>64</sup>

In addition to SBCs, electronic control units (ECU) that monitor fuel expenditures are being introduced. ECU engines have become tools that fleet managers use to control fuel costs through driver incentive programs related to idle time and vehicle speed monitoring.<sup>65</sup> Systems exist that automatically monitor engine temperature, set levels in refrigerated vehicles; and diagnostic and prognostic software packages are appearing that enable engine computers to predict component failure.<sup>66</sup>

A number of other information-based tools are allowing trucks to deliver goods with greater speed and efficiency. Although not necessarily a navigational aid, automated clearance systems in trucks increase the ease and efficiency with which truckers meet regulatory requirements at weight stations and port-of-entry facilities. A transponder is attached to the truck's windshield; and as the truck approaches a roadside check facility, the transponder identifies the truck to the site's computer, which then accesses a central database holding all of the vehicle's current safety and registration credentials.<sup>67</sup> The truck next passes over a weigh-in-motion (WIM) scale that calculates gross and individual axle weight.<sup>68</sup> If the truck meets requirements, it is allowed to proceed with shorter wait times.

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<sup>62</sup> Dan Gazzaniga, "GPS Fleet Management," *Canadian Electronics*, June 1998.

<sup>63</sup> Ibid.

<sup>64</sup> Lawson Marshall, "On Board Technology," *Fleet Equipment*, May 1998.

<sup>65</sup> Carol Birkland, "Can We Talk," *Fleet Equipment*, August 1998.

<sup>66</sup> Marshall, op. cit.

<sup>67</sup> Jim Mele, "Smart-highway Report Card," *Fleet Owner*, August 1998.

<sup>68</sup> Ibid.

***3.1.1.6 Maritime Navigation Systems***

The U.S. Coast Guard's (USCG) Maritime Differential Global Positioning System (DGPS) has become a critical component of the Nation's intermodal radionavigation system, enhancing maritime safety within harbor approaches and transits. Mariners are rapidly transitioning to Maritime DGPS-assisted navigation because of its reliability and accuracy. The USCG also operates and maintains the United States' domestic Loran-C radionavigation system that provides the maritime community with a reliable offshore, nearshore, and harbor navigational safety system. These systems have extensive applications in other transportation modes, such as trucking, aviation, automobile, and rail navigation.

The National Distress System (NDS) is the frontline communications interface with the recreational boater and the maritime industry. The NDS forms the backbone of the USCG's Short Range Communications System (SRCS), which relies on very high frequency-frequency modulation (VHF-FM) radios to provide voice communications coverage for the majority of USCG missions in coastal areas and navigable waterways where commercial and recreational traffic exists.<sup>69</sup> The NDS provides mariners calling and distress capabilities for contacting either vessels in their vicinity or the local USCG rescue unit. However, much of the existing equipment used in the system's architecture is no longer commercially available off-the-shelf, making the system increasingly difficult to support. As a result, replacement of many system components that are not commercially available has caused a lack of standardization and reliance on costly short-term fixes.

The USCG is exploring options for modernizing the NDS with the goal of providing improved communications between USCG facilities; recreational and commercial mariners; commercial service providers; and other Federal, State, and local agencies. The modernized NDS will accommodate its expanded mission using mature nondevelopmental commercial/government-off-the-shelf (COTS/GOTS) technology, particularly solutions offered by emerging wireless communications capabilities.<sup>70</sup>

***3.1.1.7 Transit Navigation Systems***

Advanced technologies are found increasingly in transit systems. Uses include data and voice communications, vehicle location through GPS, and signal priority. Transit systems in some metropolitan areas have been pursuing advanced control technology for their transit authority train lines. Currently, many trains in transit systems rely on what is called "wayside block signaling." A wayside block signaling system uses signals physically located to the side of the track (as opposed to transmitting signals directly to the train. The tracks themselves are divided into discrete track sections that electrically detect the presence of trains). Signaling is achieved

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<sup>69</sup> U.S. Coast Guard website ([www.uscg.mil](http://www.uscg.mil)).

<sup>70</sup> Ibid.

through the use of different light colors, semaphores, or other devices. A human tower operator is also needed to route the trains in the system.<sup>71</sup>

Improvements over wayside block signaling are under development and primary implementation. New York City Transit (NYC Transit) has completed design work and partial testing on a number of features designed to improve subway operations: automatic train supervision (ATV), a subway train and traffic information system (STATIS), and communications based train control (CBTC). New features will include centralized service management, easy access to train register sheets and schedules for operating personnel, and enhanced train monitoring and control capabilities.<sup>72</sup> These features will fully automate dispatching from railyards, and use existing supervisory control and data system (SCADA) information to monitor and control operating procedures.<sup>73</sup> The project also involves augmenting existing voice communications systems with online, real-time digital communications to provide instantaneous reports of fire, derailment, or other emergencies to emergency personnel.<sup>74</sup>

Another example is the San Francisco Bay Area Rapid Transit (BART) operations control center (OCC), established in 1994 to modernize the BART train control system. The OCC has provided the system with new control features that have been integrated into a single dispatch interface.<sup>75</sup> The BART SCADA system has also been upgraded with modernized technology, and all BART cab cars have been linked to an advanced spread spectrum radio network.<sup>76</sup>

Software for fixed-bus route operations is currently used to collect and process data for integrated fleet management applications.<sup>77</sup> Various transit authorities across the Nation are testing implementing technologies, such as global positioning systems, computer-aided dispatch (CAD), and other information technology support systems. These technologies are designed to help control center personnel respond to incidents, provide operators with alternate route information when needed, and provide real-time information to passengers regarding expected arrival times, delays, and other pertinent information.

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<sup>71</sup> NYC Subway Resources website ([www.nycsubway.org](http://www.nycsubway.org)).

<sup>72</sup> United States Department of Transportation, Research and Special Programs Administration, Volpe National Transportation Systems Center, *Advanced Public Transport Systems: The State of the Art*. Cambridge, Massachusetts, 1998.

<sup>73</sup> Ibid.

<sup>74</sup> Ibid.

<sup>75</sup> Ibid.

<sup>76</sup> Transportation Systems Design, Incorporated website ([www.tsd.org](http://www.tsd.org)).

<sup>77</sup> U.S. Department of Transportation, Research and Special Programs Administration, Volpe National Transportation Systems Center, op. cit.

### **3.1.2 Electronic Shipment Tracking and Identification**

Various shipment tracking and identification systems are being used by each mode of transportation used to ship freight. These technologies help prevent loss of cargo, trace the movement of goods and vehicles, and facilitate the collection of data used in emerging electronic commerce applications (see section 3.1.3).

A number of attempts have been made to establish software tools to manage the needs of the shipping industry. Some concepts proposed include designing interfaces or software allowing companies to enhance the process by which they exchange documentation with other companies or terminals, as well as augmenting the electronic customer interface that schedules and prices freight shipments.

#### **Figure 12. Innovations in Package Tracking**

In the 1980s, FedEx used a radio network and scanners to transmit delivery information throughout the company. In the 1990s, FedEx introduced a concept of real-time tracking called *Powership*. This extended the FedEx network to its customers, allowing them to track the delivery of their own packages. This technology is delivered to the customer in several different ways. Customers that ship at least 100 packages a day use an electronic data interface (EDI) personal computer (PC) provided by FedEx. It remains on site interfacing with the FedEx network 24 hours a day. Customers that ship 5 to 100 packages a day are provided with a PC and 1 to 3 printers, electronic scales, and a bar code reader. Smaller businesses or individual shippers can acquire either a tracking-only software package or a full shipping version via the Internet. Powership systems also process roughly 600,000 tracking requests per day.

Sources: Federal Express website ([www.fedex.com](http://www.fedex.com))  
The Innovation Network website (<http://innovate.si.edu>)

In the last few years, there has been a movement in the transportation industry to provide customers with constant knowledge of their freight's location and its estimated time of arrival. Recently, industry has begun to use smart tags, which contain a microchip that can be located while in route to a destination or, what is more important, while it is in the transfer process at a shipping terminal. The smart tags can be attached to various types of cargo, including containers, boxes, and letters. Smart tags are also being used in automated sorting systems. This application is called "Talking Freight in Listening Networks" and it allows freight to be sorted by tag sensor and moved through the transfer station to the correct shipping location, bin, or sorter. This process also ensures that a package has been taken off one transport and placed on the correct transport for delivery.<sup>78</sup>

The smart tag technology is also providing customers and carriers the ability to locate cargo anywhere worldwide. Companies are beginning to use both short-range radio frequency tags and long-range global positioning type tags on large amounts of their freight. Although the long-

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<sup>78</sup> Intelligent Transportation Society of America website ([www.itsa.org](http://www.itsa.org)).



range tags have not been perfected and have not penetrated the global shipping industry, forecasters believe there is a growing market for this technology.<sup>79</sup>

### *3.1.2.1 Freight Air Shipment Tracking and Identification*

Air freight companies are increasingly using information technology to improve delivery times, reduce instances of misplaced cargo, and enhance customer access to shipping information. These advances include the use of laser array technology to improve the operators' ability to load and move packages<sup>80</sup> and real-time decision support tools that provide flight and cargo alerts and inventory information tracking for specific departure gates.<sup>81</sup> High-speed TCP/IP communications networks are also being used to track shipments and meet other customer service needs.<sup>82</sup>

#### **Figure 13. A Global Information Network**

DHL operates "DHLNET," which is a global, high-speed network provided by TCP/IP over an X.25 and frame-relay backbone. The network enables customers to track shipments status and research delivery schedules and pricing information from anywhere in the world. DHLNET also provides information on routing, delivery times, and system capacity, enabling shipments to move as efficiently as possible around the world. With the initiation of DHLNET, the company has implemented automated sorting and distribution centers that record each package as it comes through and route it to the appropriate outbound flight. It also provides a backup to ensure that all packages have been properly received by the sorting/distribution center. DHLNET also allows the company to electronically declare goods to foreign customs officials.

Source: DHL website ([www.dhl.com](http://www.dhl.com))

### *3.1.2.2 Rail Shipment Tracking and Identification*

The freight rail system also relies on information technologies to track the shipment of its cargo. Tele Rail Automated Information Network (TRAIN II) is a railroad information system that provides a wide variety of services vital to the efficient operation of the railroads. As of March 31, 1996, TRAIN II maintained the movement information of 1,581,486 freight cars and 2,227,131 trailers and containers.<sup>83</sup> The Association of American Railroads (AAR) maintains the on-line database for more than 225 railroads, as well as equipment owners, that use the

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<sup>79</sup> Ibid.

<sup>80</sup> Hayes, op. cit.

<sup>81</sup> IONA Technologies website ([www.iona.com](http://www.iona.com)).

<sup>82</sup> DHL website ([www.dhl.com](http://www.dhl.com)).

<sup>83</sup> Association of American Railroads, *RAILINC Services & Publications*, July 1997.

system to send millions of events (approximately 3 million events daily) and inquiries concerning the location, and status of rail equipment.<sup>84</sup> TRAIN II consists of six components:

- waybill forward and store system,
- equipment master update system,
- parameter trace system,
- interchange continuity system,
- trip plan system, and
- output message distribution system.

Through this utility, railroads communicate with each other or with major rail customers. TRAIN II provides real-time data on car-hire settlement, customs billing, special car orders, lost or stolen equipment, car grading, optimal placement of empty cars, car-movement activity, queries, and interline tracing.

The netREDI application is another shipment tracking tool for railroad customers, administered by the AAR, which provides shipment location information from over 300 railroads in North America. This application is an Internet-based system that gives Internet access to TRAIN II data. In addition, all of the major railroads provide versions of shipment tracking information.

The IT capabilities utilized in rail systems continue to grow and coordinate a variety of activities. Since the 1970s, railroads have relied on optical tags and scanners to identify freight cars as they entered terminals. Since 1995, all freight cars and locomotives have been equipped with automatic equipment identification (AEI) tags; and AEI readers have been installed at many yards, terminals, and junction points.<sup>85</sup> More recently, railroads have gravitated to microwave transponder systems.<sup>86</sup> These systems use transponders attached to containers and railcars, which are read by readers situated alongside the rail track. However, a uniform method of AEI for all surface freight transportation modes needs to be established to further facilitate intermodalism.

### *3.1.2.3 Maritime Shipment Tracking and Identification*

Several IT programs involving partnerships between Government and the private sector have made maritime transportation more efficient and productive. For example, the Maritime Administration (MARAD) sponsors the Cargo Handling Cooperative Program (CHCP), a collaborative effort between Government and the transportation industry to help develop the use of new technologies for transportation needs. Through CHCP, prototype equipment allows unmanned vehicles to conduct shipboard inventories on containers and chasses. Hand-held computer technology is also employed to streamline data collection and transmission during

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<sup>84</sup> Ibid.

<sup>85</sup> Donald M. Itzkoff, op. cit.

<sup>86</sup> DOT Transportation Statistics Annual Report, 1997.

shipboard loading and unloading operations. A prototype video container recognition system to track containers in and out of marine terminals is currently operational in the United States and it can process a high volume of accurate transactions in a paperless shipping environment.

Recently, numerous shipping companies have introduced software programs and interfaces to automate communications pathways within the industry. These new interfaces are mostly Internet based; their enhanced digital format allows ocean vessels to exchange cargo documentation electronically over the Internet. The interfaces allow freight forwarders and trucking firms to streamline document handling with limited monetary or time investments. Before these types of document exchange programs were introduced, shipping companies had to provide, in person, such items as bills of lading, instructions for shipping, freight invoices, container status information, and motor carrier instructions. With these software programs, ocean shipping and land freight companies that are not linked by ground based information centers can improve the transfer of their cargo-related information, thus improving their customer service capabilities.<sup>87</sup>

### ***3.1.3 Electronic Commerce***

Online transactions are fundamental components of the global business environment. Major companies in all sectors, including transportation, are expanding their reach and sales capabilities through the Internet. Currently, electronic commerce (EC) applications and other online capabilities are used to complete a wide array of business transactions for both freight and passenger transportation.

Dramatic growth in the use and sophistication of Internet technologies has encouraged a rise in the EC use for business operations within the private sector and recently within the public sector.<sup>88</sup> EC benefits organizations by increasing the efficiency of their business operations and expanding their business opportunities. Advances in EC technology allow organizations to move from a just-in-case to a just-in-time approach to logistics. Just-in-case logistics involves storing large quantities of warehoused inventory just in case they are needed. Just-in-time is an inventory management process designed to reduce the warehousing of large quantities of components that may occupy a space for a brief period of time before they are needed. EC allows organizations to communicate with their suppliers at a much faster rate, allowing suppliers to fulfill their requests just-in-time. Through this capability, organizations can manage their inventories more effectively, reduce operating costs, improve customer service, and react quickly to changes in customer demand. The just-in-time approach exploits the speed and efficiency of EC to merge warehousing and transportation functions to place components at the manufacturing site or the retail store coincident with the anticipated need for the items, eliminating the need to stockpile components. Therefore, EC depends on a transportation

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<sup>87</sup> General Electric Information Services website ([www.geis.com](http://www.geis.com)).

<sup>88</sup> The NSTAC has conducted separate studies that address the vulnerabilities and NS/EP implications of the Internet and EC. Copies of the reports can be obtained from the Office of the Manager, National Communications System.

infrastructure that is sufficiently quick, agile, and reliable to deliver components by the requested date.

Companies have begun to implement enhanced software programs designed to enable customers, both domestic and international, to arrange shipments more conveniently over the Internet. These programs will allow customers to self-design their freight strategies, which will include pickup scheduling, tracking, an incorporated address book, and an archive that will allow shippers to access information on completed shipments, including when they were received.

### *3.1.3.1 Air and Electronic Commerce*

Major airlines have developed technologies to vastly improve and streamline their business transactions. Programs are being implemented that automate and expedite the passenger check-in and boarding process. Airlines also use the Internet to serve their customers more efficiently. Presently, major airlines allow customers to book travel plans, purchase tickets, and gather general company information on their Web sites. In 1996, airlines began processing tickets electronically, saving the airlines industry collectively nearly \$1 billion annually.<sup>89</sup> In early 1997, only 2 percent of air travel reservations were made via Internet bookings,<sup>90</sup> but now every major U.S. carrier has a website and online reservation service. American Airlines sells 2 to 3 percent of its tickets on its website, earning an estimated \$450 million in sales.<sup>91</sup>

#### **Figure 14. Automated Reservation Systems**

American Airlines first pioneered a reservations system in the 1930s called “request and reply,” which consisted of little more than a half dozen employees and different colored index cards. In the early 1950s, with the aid of new computer technologies, American Airlines decided to add a Magnetic Reservoir and a random access memory drum to assist in its expanding reservations business. In 1959, with the help of IBM, this capability became known as Semi-Automated Business Research Environment (SABRE), a combination of communications and real-time data processing systems. By the mid-80s, American Airlines had introduced personal computer (PC) online access, called easySABRE, to further expand its customer base. SABRE is used today to coordinate the purchase of an estimated \$40 billion in travel products and services. Although it is not the only travel information and distribution system, the SABRE network is the most widely used. In its current configuration, the SABRE data center is composed of 17 mainframe computers that process up to 190 million messages per day. SABRE is also international in scope, with travel agencies in over 70 countries directly connected to the system. Travelquest, like easySABRE, is another personal computer online reservation service. It, too, allows its customers the freedom to make their own airline, car, cruise, rail, and hotel reservations.

Source: SABRE website ([www.sabre.com](http://www.sabre.com)).

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<sup>89</sup> Standard & Poor, *Airlines Industry Survey*, March 27, 1997

<sup>90</sup> Ibid.

<sup>91</sup> Mary Hayes, “Mobility is Up, Costs are Down,” *InformationWeek*, September 14, 1998.

### *3.1.3.2 Rail and Electronic Commerce*

In addition to bar-coding, or satellite communications, the increasing trend towards EC applications in the freight rail industry is facilitated by the use of the EDI standard. EDI is defined as the computer-to-computer transfer of business documents in a standard format. This is done to reduce operating costs and the potential for human error. EDI is also crucial for rapid transfer of business information and facilitation of just-in-time ordering transactions.

Companies that ship goods via rail are finding a variety of EC options that complete fast and accurate business transactions via the Internet. Readily available EDI software, developed by the rail industry, can trace shipments, exchange e-mail notices, and transmit bills of lading via telephone connections.<sup>92</sup> For example, companies using rail to ship goods can receive information via the RAILINC data center, which is outsourced by the AAR to GE Information Services. RAILINC provides electronic commerce support to process more than 4,000,000 transactions per day, including settlements, bills of lading, ship notices, equipment tracing, rates and other business transactions among the 500 member companies of the AAR.<sup>93</sup> The RAILINC system supports the real-time exchange of business documents between the railroads, their customers, and customs officials. Additionally, most major rail carriers employ some sort of on-line transaction system, usually connected to major third-party networks, offering real-time support for basic EDI functions, electronic funds transfer (EFT), communications capabilities, and shipment tracing.

However, the use of EDI as a business communications tool has some limitations. Rail companies are beginning to consider the introduction of new, more direct communications methods for use among all major rail companies and with their customer base. In the future, the industry will likely look for new standards and formats to accommodate the interaction of varied applications and facilitate more specific electronic commerce and data processing functions.

### *3.1.3.3 Trucking and Electronic Commerce*

Bar code labels allow trucking firms to monitor individual shipments through their delivery networks, which include EDI capabilities. The EDI computer network allows truckers and shippers to access data, such as proof of delivery, invoices, shipment routing, and freight consolidation, automatically via the carrier's computer network. For example, US Freightways, one of the top 10 trucking companies based on 1996 revenues,<sup>94</sup> relies on EDI to provide information to shippers on shipment details, freight details, payment/remittance orders, advanced shipment notification, warehouse shipping orders and similar vital clerical and administrative information.<sup>95</sup> Many truckers connect to the EDI system while on the road via the Internet. For

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<sup>92</sup> EDI software is connected to the TRAIN II database.

<sup>93</sup> GE Information Services press release, April 27, 1998.

<sup>94</sup> Market Share Reporter, 1998

<sup>95</sup> US Freightways Technology Resources website ([www.usfreightways.com](http://www.usfreightways.com)).

example, the largest operator of full-service truck stops, TravelCenters of America, Inc., offers drivers a conduit through which they can access voice, data, and cable information from inside their cabs, by connecting into outlets built into asphalt truck stops.<sup>96</sup>

A number of technologies made available through devices in the truck cabs assist the drivers and fleet owners while also satisfying State and Federal transportation regulatory requirements. The trucking industry is heavily regulated, and records must be retained and produced for audits by the DOT to verify safety regulations, vehicle maintenance, and driver-rest periods.<sup>97</sup> Some State departments of transportation are using computer-aided permitting and routing systems to automate the process of issuing permits for oversize and overweight trucks and track their movement. These States use software that includes data on a State's highway infrastructure and ongoing construction activities. The software system includes forms for requesting permits, and applicants can access their application via the Internet.<sup>98</sup>

Technological advances have also resulted in electronic driver logs that are relayed through the Internet to the fleet operator. Meanwhile, portable laptops on the dashboard enable truckers not only to communicate with company computers but also register mileage or inspection results. Through the use of GPS, fuel taxes recorded by State and vehicle maintenance logs can be tracked and maintained.<sup>99</sup> The Federal Highway Administration has instructed its investigators to use satellite and other GPS records to verify paper log books, in the event that the carrier's paper records appear deficient.<sup>100</sup>

The growing use of IT has created innovative ways for trucking companies to maximize their profits. Many shippers now rely on and expect instantaneous tracking from their carriers.<sup>101</sup> One of the results of increased dependence on information technology in shipment tracking has been a proliferation of just-in-time inventory management. JIT is a higher risk, lower cost approach that relies heavily on information technology. In JIT inventory management, shippers rely upon their carriers to meet exacting reliability standards and maintain state-of-the-art shipment-tracking and communications systems.<sup>102</sup> It is expected that an increasing number of trucking companies will practice JIT inventory management.

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<sup>96</sup> Chuck Moozakis, "Web Keeps On Rollin' For Truckers," *InternetWeek*, December 7, 1998.

<sup>97</sup> As/400 Systems Management, "Trucking Company Gears Up with Imaging," July 1998.

<sup>98</sup> "Software System Eases Truck Permitting," *Civil Engineering*, July 1998.

<sup>99</sup> Gazzaniga, op. cit.

<sup>100</sup> Rita Bontz, *Overdrive Magazine*, November 1997.

<sup>101</sup> Euromonitor, *U.S. Trucking*, op. cit.

<sup>102</sup> U.S. Department of Commerce, International Trade Administration, op. cit.

**Figure 15. World-Class JIT Inventories**

Wal-Mart Stores, Inc. can fill delivery orders within 48 hours at its 2,800 stores nationally through the use of its JIT inventory management system. As a product's bar code is swiped at the checkout aisle, information is sent instantaneously to Wal-Mart's 24-terabyte data warehouse. The data warehouse, the largest known centralized decision support database, projects when the item needs to be replenished and then places the order directly to the vendor or to one of 51 Wal-Mart Distribution Centers. In addition, the company uses a computer program, RetailLink, that links buyers and vendor/partners, allowing Wal-Mart and its suppliers to monitor inventory and sales in each store. This technology provides the information needed by Wal-Mart's supply system, in which computers track every product and automatically alert warehouses when it is time to restock the shelves. This system has customized inventory for each local store and improved management of assets and inventory. Through the use of this technology, Wal-Mart realized \$1.4 billion in savings in 1998, experiencing a 12 percent increase in sales with only a 4 percent increase in inventories.

Source: Wal-Mart website ([www.wal-mart.com](http://www.wal-mart.com))

### **3.2 Industry Consolidation and Globalization**

The current environment of the transportation industry has fostered the consolidation of business operations on the national and global levels. Transportation companies have streamlined certain operations to focus on their competencies, yet have also actively sought mergers and partnerships within and across modes to offer new delivery services and acquire increased market shares. To a considerable extent, the push for consolidation and business partnerships has been facilitated by the Government's deregulation of the various industries.

#### **3.2.1 Passenger Air Consolidation**

The major air carriers generally provide worldwide service, operating aircraft with 150 to 400 seats. In addition, 26 "national" airlines, with revenues between \$100 million and \$1 billion, and approximately 104 "regional" airlines, with revenues from scheduled flights under \$100 million, also provide service.<sup>103</sup> These national and regional airlines arose in the early 1990s and began to offer a low-cost alternative to their larger airline counterparts for transportation in regional markets and for short-haul flights.<sup>104</sup>

Today, the movement of most passengers occurs via the "hub and spoke" system, where major airlines fly between larger hub airports and rely on smaller airlines to reach lightly traveled markets.<sup>105</sup> Recently, some major airlines have tried to operate as two-tiered providers of service by operating separate national and regional carriers, thereby offering complete service.

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<sup>103</sup> Ibid.

<sup>104</sup> Ibid.

<sup>105</sup> Standard & Poor, *Airlines Industry Survey*, March 27, 1997.

### ***3.2.2 Rail Consolidation***

The use of railroads to move freight has experienced steady growth for more than a decade, even though railroad track mileage itself continues to decline. While the miles of track owned by Class I freight railroads have decreased, investments in rail locomotives, rail cars, and general components of the railroad infrastructure have increased. Since 1990, the railroad industry has invested \$100 billion in its infrastructure.<sup>106</sup> In addition, revenue ton-miles reached 1.36 trillion in 1996, representing a 48 percent increase since 1980.<sup>107</sup>

Several factors have contributed to the resurgence and improved financial performance of rail transport. Deregulation of the railroad industry has given Class I railroads the opportunity to sell their less profitable lines, allowing them to concentrate on those routes that are profitable enough to justify capital investment and the introduction of new technologies for freight handling and tracking.<sup>108</sup> As a result, entrepreneurs and regional railroads have purchased portions of rail lines from Class I railroads. Railroads have also been willing to make major investments in automated systems to increase efficiency, safety and intermodal operations.

Deregulation of the rail industry has also given rise to large-scale mergers between the industry's Class I railroads. The most recent of these mergers, in which CSX and Norfolk Southern divided shares of rail carrier Conrail, created four major carriers in the United States and allowed the rail companies to provide single line rail service to new areas in the country. Mergers such as this can increase efficiency, expand market opportunities, and offer shippers routes that run parallel to heavily traveled trucking corridors, helping to keep the freight rail industry competitive.

Industry watchers expect the remaining Class I rail companies to start maneuvering for the next big merger, which might result in the establishment of a transcontinental railroad with a single point of ownership.<sup>109</sup> Members of the rail industry are also entering into marketing alliances that offer shippers competitive connections to new rail routes.<sup>110</sup>

### ***3.2.3 Trucking Consolidation***

The deregulation of the trucking industry in 1980 led to a flood of trucking companies into the market. However, this trend has been reversed in the 1990s with the current move towards consolidation, resulting in fierce competition between trucking companies to maximize slim

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<sup>106</sup> M.B. Oglesby, Jr., President and CEO Association of American Railroads, *Testimony Before the Subcommittee on Surface Transportation and Merchant Marine, Committee on Commerce, Science and Transportation, United States Senate*. February 25, 1998.

<sup>107</sup> DOT, *Transportation Statistics Annual Report*, Washington, DC, 1998.

<sup>108</sup> Ibid.

<sup>109</sup> Justin Martin, "The Great Train Game," *Fortune*, November 11, 1996.

<sup>110</sup> "Canadian National, Illinois Central, and Kansas City Southern Railway Form Pro-Competitive Alliance to Link Key North American Markets with New Rail Freight Services," *Transport News*, April 17, 1998.



profit margins. To remain in the LTL market, national carriers have had to cut transit costs and times;<sup>111</sup> only 5 of the top 50 carriers in 1980 have survived the post-deregulation period.<sup>112</sup>

The advent of direct loading is another restructuring of the trucking industry that has maximized profits. With direct loading, the freight comes into one terminal and is then loaded onto a larger truck for delivery to a destination terminal, regardless of whether the truck is full or partially loaded.<sup>113</sup> Trucking companies have used this practice to restructure their terminal networks, abandoning the traditional hub-and-spoke terminal structure. Although hub-and-spoke operations are efficient for maximizing the use of trucks on shorter routes, the demands on fleets today to provide time-definite delivery have caused it to become outdated. The hub-and-spoke system forced customers to pay for longer hauls because satellite terminals were sometimes in the wrong direction from the destination of the freight.<sup>114</sup> Many LTL carriers are replacing their hub-and-spoke terminals with direct loading and strict cutoff times.<sup>115</sup> This transport system reduces the time and cost of handling, cuts delivery times, and limits the potential for damage.<sup>116</sup> For example, Consolidated Freightways, one of the top three in the LTL market, reduced its average transit time from more than 4 days to 3.2 days by replacing the hub-and-spoke system with direct loading. This transit time is expected to be less than 3 days by the end of 1999.<sup>117</sup> Globalization of the trucking business has resulted in global outsourcing, competition, and selling, which have in turn fostered a growth in international trucking. The North American Free Trade Agreement (NAFTA) has caused an increase in the amount of trucking business conducted with Mexico; trucks move 80 percent of the \$100 billion trade between the United States and Mexico.<sup>118</sup> However, major differences exist in U.S. and Mexican commercial trucking regulations and operating practices, including record-keeping requirements. Many of the Mexican trucks do not meet U.S. safety standards; and according to Mexican officials, there has been little truck enforcement activity to date in Mexico.<sup>119</sup> In December 1995, Federal, State, and local officials in the four U.S. border States began an intensified effort to inspect trucks arriving from Mexico.<sup>120</sup> As the inspection process becomes easier with the use of technology in most States across the country, the border States may find it costly to continue manual inspections.

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<sup>111</sup> U.S. Department of Commerce, International Trade Administration, op. cit.

<sup>112</sup> Transport Topics website ([www.ttnews.com](http://www.ttnews.com))

<sup>113</sup> U.S. Department of Commerce, International Trade Administration, op. cit.

<sup>114</sup> Transport Topics, op. cit.

<sup>115</sup> U.S. Department of Commerce, International Trade Administration, op. cit.

<sup>116</sup> Ibid.

<sup>117</sup> Transport Topics, op. cit.

<sup>118</sup> General Accounting Office, "Commercial Trucking Under NAFTA," RCED-96-61.

<sup>119</sup> Ibid.

<sup>120</sup> Ibid.

### ***3.2.4 Intermodal Consolidation Trends***

Numerous companies around the world have announced their intentions to purchase other freight or transportation companies or enter into joint ventures with them to enhance the capabilities of their international delivery services. This trend is particularly true for those companies striving to achieve a door-to-door delivery service capability. Many intermodal companies will ship any item from cars to frozen food, by boat, train, airplane, or truck. The process of door-to-door shipment can be costly; however, when companies have the option of owning or entering into partnerships that include these mediums of transportation, operation costs can be lowered dramatically. Furthermore, partnerships with companies based in other countries not only allow U.S. firms to expand their service capabilities but also capitalize on the cargo management and customs clearance competencies of the firms with which they seek to partner or to acquire.<sup>121</sup>

### **3.3 Enhancements in Intermodal Transportation Efforts**

The nature of intermodal transportation has changed dramatically in the information age. Automation and state-of-the-art computer and tracking systems have changed intermodal standards within the entire transportation industry and increased customer expectations regarding intermodal capabilities. The improved efficiency of U.S. transportation systems in an intermodal context has resulted in what many experts call the “land bridge.” In the past, it was cheaper and more efficient for a manufactured good produced in Japan and targeted for distribution in Europe to be transported via ship through the Panama Canal. With the commercial efficiencies currently in the U.S. transportation industry, it is now cheaper and faster to transport that same product to the west coast, move it across the United States by rail or truck, and load it on a vessel bound for Europe on the east coast.

Information technology has allowed companies to centralize both their shipping facilities and information dispatching centers. Currently, the intermodal industries focus on the competition to provide door-to-door shipping services while allowing customers to track their parcels while in route to their destination. The following sections focus on methods companies are using to meet these criteria.

#### ***3.3.1 Containerization Specialization***

In the late 1960s and early 1970s, industry-wide demand increased for a standard receptacle that could be used for intermodal shipping purposes. In response to this demand, shipping and freight companies developed a cargo storage receptacle or “container” of uniform shape and size. This container design allowed a company to load freight into a container and place it on a ship, transport it across an ocean, and place it on a train without the contents ever having to be

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<sup>121</sup> United Parcel Services website ([www.ups.com](http://www.ups.com)).

removed and transferred to a different container. This development ensured ease of transfer between modes of transportation as well as increased security of shipping parcels.

The use of specialized containers has increased and expanded over the last 25 years, so too has the development of the container structure and its available applications. In recent years, containers have been specialized to provide for differentiation within the shipping industry. For example, a relatively new fleet of containers has been designed to a smaller standard size and has incorporated supports or "axles" allowing them to be placed directly on trucks for inland transport. Additionally, as containerization has continued to develop, joint ventures and partnerships among freight companies in each transportation mode have been formed. The result is faster and more efficient service for customers, leading to door-to-door shipping capabilities.<sup>122</sup>

As stated above, containerization has acted as a catalyst for a new sector of the intermodal industry—specifically, the development and manufacturing of different kinds of containers in an attempt to meet the needs of different types of cargo. For example, numerous companies have begun to develop specific types of containers, such as heating and air conditioning containers for trucks, rail cars, and ocean-going vessels. These types of containers enable the shipping of items that require transport at constant temperatures, such as perishable items or microchips.

### ***3.3.2 Superports and Port Modernization***

In the past few years, a number of intermodal freight companies have announced their intentions to build chief shipping ports and hubs around the world. These "superport," or chief shipping, hubs are designed to centralize the cargo transitions that must be made from sea to land, land to sea, land to air, and air to land. Along with centralizing the location of these transition areas, the majority of these companies are using these new facilities to incorporate numerous modern telecommunications systems. For example, many companies use the new global position tracking and navigational systems, as well as Intelligent Transport Systems (ITS).

Initial concepts of these superports are under way, with exploratory efforts focusing on identifying sufficient harbors in which to base a new generation of larger vessels. Superports are expected to double the volume of freight the companies can store and transfer.<sup>123</sup> A number of major issues must be considered, such as water depths in the prospective harbors, access to railways, and traffic concerns for highway truck shipping.

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<sup>122</sup> Interpool, Inc. website ([www.interpool.com](http://www.interpool.com)).

<sup>123</sup> Daniel Machalaba, "Shipping Companies Select Superport Finalists," *Wall Street Journal*, December 11, 1998.

**Figure 16. The Superport**

A few Superport Projects are under way. DHL and UPS are scheduled to have the initial operations of their next-generation shipping hubs completed by 2001. Sea-Land Service Inc. and Maersk Inc. are continuing to examine several eastern North American ports to establish their proposed deep-water shipping center.

These centralized shipping locations or “superports” are being designed to consolidate transactions from one form of intermodal transportation to another, as well as centralize communications and document handling within the company. Advanced tracking systems will also be a key component of superports, enabling both shipping companies and customers to track the location of a package.

However, there are potential barriers to superport completion. Ideal locations must be found at which these sizeable centers can be constructed, providing proximity to other shipping modes and sufficient water depth. Securing the approval of Federal, State, and local transportation authorities is another anticipated impediment.

Sources: United Parcel website ([www.ups.com](http://www.ups.com))  
DHL website ([www.DHL.com](http://www.DHL.com))

Shipping and freight companies are not the only groups involved in ensuring that port facilities are upgraded to a level that encourages expansion and the incorporation of innovative technologies in the intermodal freight arena. Cities around the world are taking the appropriate steps to ensure their communities are prepared to meet the needs of intermodal transportation and industry well into the future.

**Figure 17. Alameda Corridor Project**

The cities of Los Angeles and Long Beach, California, are two U.S. communities involved in intermodal planning efforts. A project known as the Alameda Corridor is designed to provide much more efficient highway and railroad access to these cities. Features of the project include consolidating railroad traffic, incorporating state-of-the-art-train and traffic control systems, and establishing industry direct loading facilities connected to area railroad lines. Highway improvements in the corridor include the widening of the current Alameda street capacity and the limitation of signals and other traffic inhibitors.

Through these intermodal-specific planning efforts, the corridor is projected to facilitate the transport of 121 percent more cargo in 2020 than in 1991. The corridor is also expected to support more than two times the truck movements per day and three times the train movements per day in 2020 than it did 1991.

Source: Alameda Corridor Transportation Authority

### ***3.3.3 Information Centers***

Paralleling the movement to construct larger and more technologically advanced shipping facilities, many corporations have decided to establish more advanced information and customer service centers. The design of these centers will be based around state-of-the-art network computer systems, allowing both a telephony and client/customer software interface. Many companies are also incorporating centralized real-time cargo tracking systems to work in conjunction with the latest freight identification tags being used throughout the industry.

A number of the lead companies investing in this type of information/data center have been relocating to centralized locations that will allow them to create more technically enhanced and useful network-based computer systems. The facilities are designed to consolidate communications and allow the companies to streamline operations while meeting the current business and customer needs. These companies believe that these centers will also give them the opportunity to project possible business opportunities that may arise.<sup>124</sup>

The recent movement by many corporations to invest in more advanced data/information centers is the core of a greater industry strategy to provide both customers and delivery agents with a centralized location from which to manage and direct deliveries. These locations control pickup and delivery scheduling, guidance, and real-time tracking services. The companies involved are attempting to construct state-of-the-art computer automated services designed to provide cost efficient, time-sensitive deliveries while allowing customers to locate their freight in route.

### ***3.3.4 Intermodal Developments by Transportation Mode***

The operations of each of the modes composing the transportation industry are becoming increasingly intermodal. This section describes the mode-specific intermodal issues.

#### ***3.3.4.1 Air Transport***

Although most of the discussion regarding intermodal transportation is centered on the transfer of cargo from one mode to another, the intermodal aspects of passenger travel are becoming increasingly important. Because airports are often located many miles from the city centers they serve, airport and city planners are realizing the need to ensure efficient intermodal transportation options are available for airline passengers to reach their destination city.

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<sup>124</sup> Crowley Maritime Corporation website ([www.crowley.com](http://www.crowley.com)).

**Figure 18. Multimodal International Cargo Distribution Center**

Rickenbacker is a multimodal, international cargo distribution center in Columbus, Ohio. The center consists of a 5,000-acre airport and a 2,000-acre foreign trade zone which are dedicated to cargo and distribution operations. Its location and dedication to cargo operations allow for lower costs than other North American gateway airports, with the overall cost of moving air cargo through Rickenbacker being 50 percent less than New York's JFK airport, and 35 percent less than Chicago's O'Hare. The increased cost at other facilities is attributable to congestion and time delays. Rickenbacker International Airport handles approximately 333 tons of freight per day, and plans envision the airport as a multimodal gateway port with adjacent manufacturing and assembly facilities as well as direct rail and motor carrier intermodal connections. Currently, Federal Express operates one of its six U.S. cargo hubs from a 274,000 square foot sortation center located at Rickenbacker.

Source: Rickenbacker International Airport website ([www.rickenbacker.org](http://www.rickenbacker.org))

However, airports are also being designed with the intermodal needs of the growing air freight industry in mind. Increasing quantities of cargo are being transported by all-cargo airlines, resulting in widening differences between an airport's cargo and passenger operations. All-cargo airports are being developed in specific geographic regions around the country with attention being given to ensuring intermodal capabilities are available to support the manufacturing, supply chain management, and distribution needs of industry.

#### *3.3.4.2 Rail*

The U.S. intermodal rail industry has been robust, moving approximately 8.1 million trailers and containers across the country each year.<sup>125</sup> According to the AAR, intermodal rail is the fastest growing segment of the U.S. railroad industry, representing approximately 17 percent of freight revenue for all railroads. This growth is spurred by the expected decrease in the numbers of long distance truck drivers and fluctuating fuel prices.

The intermodal trend is likely to have international implications for the freight rail industry, as marketing alliances have already been formed between U.S. railroads and affiliated intermodal companies and their international counterparts. Such alliances have the potential to combine existing intermodal services and EDI networks in Europe and the United States while bundling domestic freight services, shipment pricing, and tracking.<sup>126</sup>

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<sup>125</sup> Margaret Allen, "Burlington Freight Yard Tracks Booming Growth," *Dallas Business Journal*, October 20, 1997.

<sup>126</sup> Norfolk Southern Press Release. June 13, 1997.

### *3.3.4.3 Trucking*

Trucking also plays a major role in most intermodal freight shipping. Trucks often are used as the final transport method for cargo that is delivered to railyards, airports, and marine ports. Intermodal methods for freight transfer are becoming economically advantageous. The result has been an increase in the trucking industry's partnership with the railroad industry, in which the short-haul portion of the shipment is performed by trucks; and the shipments of more than 500 miles are hauled by railroads. In the future, these partnerships could cause amalgamation of carriers into a single system of multimodal, multifaceted logistics providers.<sup>127</sup> Part of the success of intermodal alliances is attributable to the use of information technology and common software. It is not uncommon for a TL carrier to transfer freight to railroads for long hauls, then arrange drayage at either end. The carrier that retains the primary link to the shipper is responsible for putting the containers on the rails, thus enabling the carrier to cut transportation costs while reducing the need for over-the-road equipment.<sup>128</sup> According to the Intermodal Association of North America, the railroad industry in 1994 held 18 percent of the market in shipments for general freight moving over 500 miles, up from 10 percent in 1991. Much of this increase represents business directed to the railroad from truckload carriers.<sup>129</sup> Currently, trucking companies compose less than 10 percent of the intermodal market; but according to industry analysts, this figure could double in the next 10 years.<sup>130</sup>

### *3.3.4.3 Waterways*

The U. S. port system provides the interface between water and land transportation and serves both the international and domestic segments. The growing dependence on intermodal transportation requires increasing landside access to marine terminals and ensures that ports become more involved in local transportation planning initiatives. The port industry will likely address issues related to intermodalism due to the key role ports play in the Nation's intermodal transportation system and national defense. Improved intermodal connections at port terminals can alleviate urban congestion, speed commerce, and increase capacity or throughput.

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<sup>127</sup> "IT to Drive Trucking," *Beverage Industry*, November 1, 1998.

<sup>128</sup> Robert Bowman, "Top Motor Carriers Keep on Trucking," *World Trade*, December 1998

<sup>129</sup> U.S. Department of Commerce, International Trade Administration, op. cit.

<sup>130</sup> Ibid.

## **4.0 TRANSPORTATION INDUSTRY/GOVERNMENT RELATIONS**

The U.S. transportation industry maintains a web of complex and interrelated relationships with Federal, State, and local authorities. Those relationships have three dimensions: supporting the development of the transportation industry, regulating transportation, and protecting the transportation infrastructure. Each relationship is discussed in detail below.

### **4.1 Supporting the Development of the Transportation Industry**

Transportation plays a crucial role in the economic vitality and competitiveness of the United States. Efficient transportation gives U.S. companies a comparative advantage and provides Americans with affordable and accessible products. The transportation infrastructure also promotes an increased mobility of goods and services across the country and in the global economy. For these reasons, an important role for Government is the promotion of the transportation industry's interests through infrastructure investment, modernization, and research and development.

The U.S. Congress plays a central role in developing, maintaining, and improving the transportation infrastructure. For nearly 40 years, Congress focused almost exclusively on expanding the Interstate Highway System. Recognizing trends in the transportation infrastructure and the need for legislative change, Congress passed the groundbreaking Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) that formally acknowledged a new era in transportation, deemphasizing highway construction and prioritizing systems management.

ISTEA was revolutionary in a number of ways. The Act envisioned an intermodal framework for transportation policy. Specifically, it promoted intermodal transportation as a facilitator of economic development and global competitiveness, a self-proclaimed ISTEA cornerstone.<sup>131</sup> The Act also placed unprecedented control in the hands of State and local governments, enabling the advancement of intermodal programs. Perhaps the most important aspect of the Act was its emphasis on developing new technology solutions to transportation issues.<sup>132</sup>

The Intelligent Transportation System (ITS) program emerged as a result of ISTEA. The goal of ITS is to provide an intelligent transportation infrastructure that enables easy information access across agency and organizational lines, especially in metropolitan areas. Such an infrastructure

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<sup>131</sup> Sarah J. Siwek & Donald H. Camph, *Listening to America: Report on the U.S. Department of Transportation's Outreach on Implementation of the Transportation Equity Act for the 21<sup>st</sup> Century (TEA-21)*, United States Department of Transportation, January 1999.

<sup>132</sup> John W. Fischer, "ISTEA Reauthorization: Highway Related Legislative Proposals in the 105th Congress, " *Congressional Research Service Report for Congress*, October 1997.



would combine technological controls with the power of information, enabling people and products to be moved more efficiently and safely.

In 1995, DOT partnered with ITS America, an organization created to link the public and private sectors of the ITS program, to identify nine infrastructure components that would act as building blocks for new technologies and development:

- traffic signal control,
- freeway management,
- transit management,
- incident management,
- electronic toll collection,
- emergency management services,
- electronic fare payment,
- highway-rail intersection, and
- regional multimodal traveler information.

The ITS program posits the management of multimodal travel through these components. Fully instituted, the ITS program will also regulate commercial vehicle operations, including credential checks, safety inspections, on-board monitoring, freight mobility, and hazardous materials incident management systems. The program also seeks to deploy advanced vehicle control and safety systems, including intelligent cruise control and collision avoidance systems. In 1996, former Secretary of Transportation, Federico Peña, announced the “Operation TimeSaver” initiative, the goal of which is to deploy a complete Intelligent Transportation Infrastructure (ITI) nationwide by 2006.<sup>133</sup>

Intelligent transportation system development is not limited to the United States. Motivated by growing traffic congestion in the late 1980s, Japan launched its own ITS program. ITS programs in Europe predate ITS America and fall predominantly under local jurisdiction. This approach allows cities to realize direct results and returns on their investments, which in turn creates incentives to develop and implement new systems and technologies.

Congressional activity on enhancing and modernizing the transportation infrastructure continued beyond ISTEA. The Act was extended while Congress debated numerous transportation bills, including President Clinton's National Economics Crossroads Transportation Act (NEXTEA), Senator Daniel Moynihan's (D-NY) ISTEA Reauthorization Act of 1997, and Representative Bud Schuster's (R-PA) Building Efficiency through Surface Transportation and Equity Act of 1997 (BESTEA). As a compromise, the Transportation Equity Act for the 21<sup>st</sup> Century (TEA-21) was signed June 9, 1998. That Act introduces another record level of investment in

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<sup>133</sup> U.S. Department of Transportation, Intelligent Transportation Systems Joint Program Office: Summary of Activities.

transportation and integrates a number of issues into one act while retaining the emphasis on intermodalism and ITS development.

TEA-21 shifts the focus of ITS from research to widespread deployment. Since ISTEA 1991, approximately \$200 million has been allocated annually for ITS research and deployment; by 2003, this amount will reach approximately \$230 million.<sup>134</sup> TEA-21 tasks the DOT with developing, implementing, and maintaining both a national ITS program plan<sup>135</sup> and a national architecture and standards.<sup>136</sup> TEA-21 instructs the Secretary of Transportation to present a preliminary list of ITS standards to Congress by June 1, 1999. Under TEA-21, critical standards must be adopted by 2001. With a national architecture and standards in place, the Federal Government hopes to promote ITS implementation through State and local governments and the private sector.

To satisfy these requirements, DOT developed the ONEDOT concept (One Department of Transportation), which would symbolically restructure DOT to integrate all operating administrations and create an agency that mirrors the intermodalism trend embedded in ISTEA and TEA-21. The ultimate purpose of ONEDOT is to revitalize DOT and work with the private sector “to build a transportation system that is international in reach, intermodal in form, intelligent in character, and inclusive in nature.”<sup>137</sup>

## **4.2 Regulating Transportation**

Like other sectors of the U.S. economy, the transportation industry has undergone significant deregulation since the 1980s. Nonetheless, Federal and State agencies continue to play an important role in regulating the industry. The level and type of government involvement depend largely on the mode of transportation and whether that transportation frequently involves the crossing of State or national borders. While most of the transportation modes operate in a deregulated environment, varying levels of regulatory control exist. At the Federal level, the Department of Transportation houses eight operating administrations with regulatory responsibilities for the transportation industry. Figure 19 defines the regulatory responsibilities of those operating administrations.

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<sup>134</sup> “Intelligent Transportation, International Style,” *Government Technology*, November 1998.

<sup>135</sup> Transportation Equity Act for the 21st Century, Public Law 105-178, section 5205.

<sup>136</sup> Ibid., section 5206.

<sup>137</sup> U.S. Department of Transportation, *U.S. DOT Strategic Plan for Fiscal Years 1997-2002*. Washington, DC, 1996.

**Figure 19. U.S. Department of Transportation  
Regulatory Agencies and Missions**

<b>Agency</b>	<b>Mission</b>
Federal Aviation Administration	To provide a safe, secure, and efficient global aviation system that contributes to the national security and promotion of U.S. aviation.
Federal Highway Administration	To preserve the key principles that help to keep the United States competitive in the emerging world economy and to assist in the preservation of the infrastructure and connections that allow the U.S. transportation system to be truly intermodal.
Federal Railroad Administration	To promote safe and successful railroad transportation to meet current and future needs of all customers and to encourage policies and investment in infrastructure and technology to enable rail to realize its full potential.
Federal Transit Administration	To ensure personal mobility and America's economic and community vitality by supporting high-quality public transportation through leadership, technical assistance, and financial resources.
Maritime Administration	To promote the development and maintenance of an adequate, well-balanced United States Merchant Marine sufficient to carry the Nation's domestic waterborne commerce and a substantial portion of its waterborne foreign commerce and capable of serving as a naval and military auxiliary in time of war or national emergency.
National Highway Traffic Safety Administration	To reduce deaths, injuries, and economic losses resulting from motor vehicle crashes by setting and enforcing safety performance standards for motor vehicle equipment and through grants to State and local governments for enabling them to conduct effective local highway safety programs.
Research and Special Projects Administration	To conduct and foster cross-cutting research and special programs to enhance the quality of life, safety, the environment, and the economic well-being of all Americans.
United States Coast Guard	To promote maritime safety, conduct search and rescue operations, protect the environment, protect commerce and communities, and conduct effective drug interdiction.
Office of the Inspector General, DOT	To promote efficiency and effectiveness and to prevent and detect fraud, waste, and abuse in departmental programs and operations. Conduct and supervise audits, evaluations, and investigations.

These regulatory activities focus primarily on public health and safety. There are several reasons why public safety is a particularly sensitive issue for the transportation industry. Unlike other infrastructures, where safety issues are important but less visible, transportation accidents such as airplane crashes or train derailments often occur in the public spotlight and receive widespread media attention. Other public safety concerns such as the movement of hazardous materials and perishable food supplies, restrictions on work hours (e.g., limitations on truckers and airline pilots), and corrective safety measures for transportation assets also require Federal involvement in the industry through regulation. This regulation can take many forms, ranging from safety codes and specifications to taxes and tolls on vehicles.

In addition to the agencies listed in Figure 19, the National Transportation Safety Board (NTSB) plays an important role in promoting public safety. Created in 1967, the NTSB is responsible for determining the probable causes of transportation accidents and formulating recommendations to

improve transportation safety. While publicly recognized for its role in investigating civil aviation accidents, the NTSB investigates significant accidents in other modes of transportation and recommends actions to prevent future accidents. The NTSB operates as an independent, congressionally mandated board that provides objective and unbiased analysis of transportation incidents. It has no authority to develop regulations, but the FAA and other DOT operating administrations implement approximately 80 percent of NTSB recommendations as Federal regulations.

### **4.3 Protecting the Transportation Infrastructure**

Transportation assets and facilities are highly visible and, therefore, often targets of criminal or terrorist acts. For example, organized crime often targets high-value cargoes of electronic or computer equipment for theft. On the other hand, international terrorists have traditionally targeted transportation assets like aircraft for bombing or hijacking to make a political statement that attracts mass media attention. The Federal Government plays an important role in protecting the transportation infrastructure in two separate but interrelated contexts: law enforcement and national security and emergency preparedness (NS/EP).

#### ***4.3.1 Law Enforcement***

Elements of the transportation industry interact frequently with Federal, State, and local law enforcement organizations regarding cross-border and customs issues, criminal acts, and possible terrorist activities. This section briefly lists the agencies with law enforcement responsibilities and describes the growing problem of cargo theft.

##### ***4.3.1.1 Federal Law Enforcement Agencies***

Three Federal agencies play a prominent role in law enforcement activities related to the transportation industry. The first is the Department of Transportation through the United States Coast Guard. In addition to its regulatory and public safety missions, USCG is responsible for enforcing the law in the Nation's ports and waterways and overseeing the enforcement of U.S. laws and treaties in the areas of drug interdiction, living marine resources, and alien migrant interdiction. The USCG is the lead Federal agency for maritime drug interdiction and shares lead responsibility for air interdiction with the U.S. Customs Service.

The U.S. Department of the Treasury also plays an important role through several of its bureaus. For instance, the U.S. Customs Service monitors the flow of goods and services between the United States and its foreign trade partners. To handle the demands posed by increasing international trade, Customs is automating its processes to manage the flow of goods and services and exact the appropriate tariffs and taxes. It is also involved with the Immigration and Naturalization Service in the Border Coordination Initiative (BCI) to manage and monitor port traffic and air and maritime freight and to interdict the flow of illegal drugs and other materials.

The Drug Enforcement Agency and U.S. Secret Service may also interact with the transportation industry in cases involving the distribution of illegal narcotics, counterfeiting, or money laundering.

The FBI is involved with the transportation industry in many areas. For instance, the FBI is responsible for issuing warnings to airports, other transportation facilities, and transportation carriers about potential terrorist activity. It also assumes the Federal lead in investigating terrorist acts against domestic transportation assets or facilities. The FBI is also responsible for investigating cargo theft and other crimes against transportation companies that cross State lines.

#### *4.3.1.2 Investigating Cargo Theft*

Cargo theft represents the most prevalent transportation-related crime and increasingly requires the involvement of Federal, State, and local law enforcement. Experts estimate that cargo theft results in \$4 to \$10 billion in annual losses.<sup>138</sup> Despite recent Government statistics indicating an overall decline in crime rates, it is generally accepted within the transportation industry that the rates of cargo crime and theft are increasing.<sup>139</sup> In fact, recent estimates indicate that cargo theft has become a widespread problem, increasing nearly threefold in this decade alone.<sup>140</sup> According to the American Trucking Association, the top commodities stolen are, in descending order:

- food,
- electronics,
- high-end clothing,
- computer and computer components,
- perfumes, and
- toiletries.<sup>141</sup>

The impact of cargo theft cannot be measured simply in terms of stolen goods. With increasing reliance on just-in-time systems, victimized companies stand to suffer additional losses in terms of sales, customers, and revenue.<sup>142</sup>

Several factors drive the increase in the number of cargo thefts. The first is that the same technologies and techniques that make transportation more efficient and competitive also aid

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<sup>138</sup> Truckload Carriers Association.

<sup>139</sup> Edward Badolato, Chairman of National Cargo Security Council (NCSC) speaking at the NCSC Sponsored Forum on Cargo Theft, June 15, 1998.

<sup>140</sup> Ellen Rettig, "Rising Cargo Crimes Plague Distributors," *Indianapolis Business Journal*, July 1998.

<sup>141</sup> David Reich-Hale, "Cargo Tips' Snuffs Out Roadway Theft," *National Underwriter/Property & Casualty Risk & Benefits*, November 1998.

<sup>142</sup> *Ibid.*

criminals in their efforts to identify and steal the most vulnerable and valuable cargo.<sup>143</sup> Information technologies give criminals valuable tools (e.g., bar code readers, delivery tracking databases) to identify and steal high-value cargo. The second factor is that outdated laws and sentencing guidelines no longer serve as deterrents. The laws on interstate cargo theft have changed little since they were written in 1913.<sup>144</sup> A third factor is that many cargo crimes can involve multiple jurisdictions. Valuable time is often spent coordinating State and local law enforcement with Federal authorities (e.g., U.S. Customs, FBI, and the Drug Enforcement Agency).<sup>145</sup> A fourth factor is the uneven reporting of cargo theft. Some companies choose not to report cargo theft, preferring to write-off losses instead of becoming involved in a long, complicated criminal prosecution.

To address growing losses associated with cargo crime, Congress has considered enacting legislation to amend existing cargo theft laws to include tougher penalties. Industry associations have been supportive of such Congressional initiatives. In addition to legal deterrence, cargo shippers and the FBI are utilizing information technologies to track and trace their fleets in order to overcome jurisdictional issues. With the use of satellite tracking devices on trucks and soon in containers, fleet managers can pinpoint the location of a missing shipment.<sup>146</sup> ATA has also developed CargoTips, an automated system that includes a database of cargo theft incidents and sends e-mail alerts to subscribers. The FBI has also created the Criminal Intelligence Support Program (CISP), a database designed to track cargo thefts and other crimes. CISP will serve as a clearinghouse for information from other Government agencies and private industry, to be housed on a private network.<sup>147</sup>

#### ***4.3.2 National Security and Emergency Preparedness***

Historically, the transportation infrastructure has played an important role in supporting the NS/EP requirements of the United States. Transportation assets, both public and private, were used to support U.S. force deployment to the Persian Gulf during Operations Desert Shield and Desert Storm. Through the Civil Reserve Air Fleet (CRAF) program, commercial passenger and freight carriers provided aircraft and crews to support the airlift of personnel and materials to the Gulf. Similarly, commercial vessels were used to transport heavy military equipment, such as tanks and motorized artillery. Finally, domestic transportation assets and infrastructure, most notably railroads, helped move heavy weapons platforms, munitions, hazardous materials, and other supplies to port facilities. The transportation industry also provides essential services during natural disasters. In the aftermath of Hurricane Andrew, for instance, the transportation industry provided the air, rail, and trucking capacity to support emergency relief operations.

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<sup>143</sup> Steve Barth and Michael White, "Hazardous Cargo," *World Trade*, November 1998.

<sup>144</sup> Ibid.

<sup>145</sup> Ibid.

<sup>146</sup> Barth and White, op. cit.

<sup>147</sup> Dequendre Neely, "FBI Steps Up Cargo Security," *Security Management*, January 1998.

Security problems in the transportation infrastructure often manifest as physical threats. As noted previously, transportation assets and facilities are high-impact, high-visibility targets for criminal organizations, terrorist groups, and other organizations. The most recognizable physical threats are terrorist activities against aircraft and airports. The White House Commission on Aviation Safety and Security analyzed terrorist and other physical threats to the airline industry in its 1997 report to President Clinton and Vice President Gore. That report outlined several high-level findings related to increasing airline safety programs, national airspace management, and security.

Concerns in the Government about the ability of electronic intruders to exploit vulnerabilities in information systems emerged in 1996. In particular, several Federal initiatives, including the President's Commission on Critical Infrastructure Protection (PCCIP), examined infrastructure dependencies on cyber systems. The fear was that disruptions of cyber systems could significantly impact the operations of other critical infrastructures (e.g., electric power, banking, and finance). For the transportation industry, this fear was exacerbated by an increasing reliance on advanced information technologies, such as wireline and wireless communications, remote traffic routing, GPS, supervisory control and data acquisition systems, and the Internet.

The PCCIP focused on several transportation-related issues, including separate studies on the vulnerabilities of the rail industry and GPS. The PCCIP report, *Critical Foundations*, and other Government initiatives led to Presidential Decision Directive 63 (PDD-63) on May 22, 1998. That directive outlines a national strategy for eliminating critical infrastructure vulnerabilities by forging a stronger public-private partnership that is "genuine, mutual, and cooperative."

Under the provisions of PDD-63, DOT was assigned the responsibility of Lead Agency for the Transportation Sector. Those duties are outlined below:

- partnering with industry to identify infrastructure vulnerabilities,
- working with a Sector Coordinator from the private sector to develop a transportation infrastructure assurance plan that will be part of a national plan, and
- conducting an industry education and awareness plan.

The two transportation workshops sponsored by the NSTAC and supported by the Department of Transportation were an initial attempt to raise industry awareness of cyber threats. The Secretary of Transportation designated the Office of Intelligence and Security to serve as the Sector Liaison Official for the transportation industry.

## **5.0 FINDINGS**

The purpose of this study is to identify and analyze emerging information-based risks to the United States transportation information infrastructure. The transportation information infrastructure includes all of the public and private information systems and networks that support the movement of people and goods across the United States. Those systems and networks range from proprietary corporate systems supporting individual carriers to large-scale systems such as GPS that support the entire infrastructure. The diversity among and across the different modes makes an assessment of the overall risk to the transportation information infrastructure quite difficult. As noted throughout this study, the transportation infrastructure can be characterized as a collection of separate but interrelated infrastructures that often employ different business models and strategies. For this reason, this report is limited to analyzing those information-based risks identified by industry representatives participating in the NSTAC Transportation Risk Assessment workshops.

In analyzing risks to the transportation information infrastructure, the IIG used a methodology developed by the joint Government and NSTAC Network Security Information Exchanges (NSIEs). The NSIEs periodically assess the risks to the security of the public network (see Figure 20) using a risk assessment methodology comprising four elements: **threats**, which are mitigated by **deterrents**; and **vulnerabilities**, which are mitigated by **protection measures**.

This section is organized in accordance with this methodology and summarizes the findings related to the security of the transportation information infrastructure. In addition, it outlines some other high-level findings identified during the NSTAC workshops.

*Figure 20. Assessing the Risks to the Security of Public Networks*

The U.S. Government and NSTAC Network Security Information Exchanges are separate but closely coordinated bodies that exchange information on risks to telecommunications and related information systems in a trusted environment. Operating under the provisions of non-disclosure agreements, the NSIE membership includes network security practitioners from industry who meet bimonthly with their counterparts in Government to share threat and vulnerability information. To share its findings and observations with a larger community of security professionals, the NSIE periodically publishes an assessment of the risks to the security of the public network. As defined by the NSIE, the public network includes “any switching system or voice, data, or video transmission used to provide communications services to the public (e.g., public switched networks, public data networks, private line services, wireless systems, and signaling networks).” The most recent version of the NSIE risk assessment was released in April 1999.



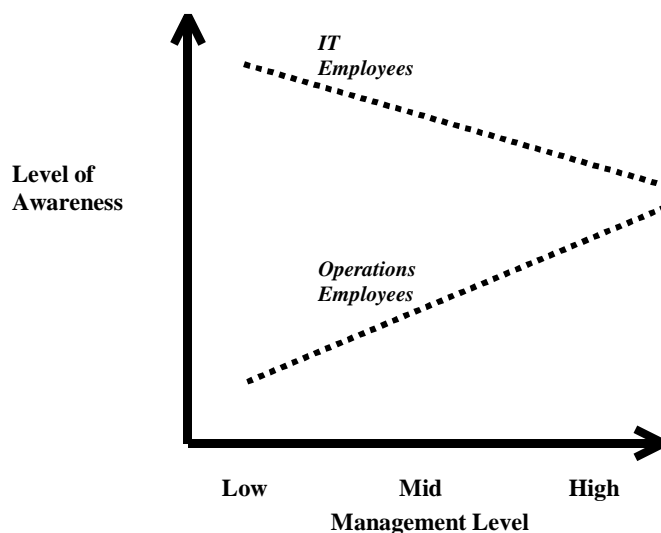
## **5.1 Threats and Deterrents**

Threats to the transportation infrastructure originate from three categories of sources. The first category of threat consists of natural and man-made disasters, such as hurricanes, earthquakes, fires, tornadoes, and floods, that have historically represented a significant threat to the U.S. transportation industry and its supporting physical infrastructure. The second category includes concerns about the threat of physical harm, destruction, or theft of transportation assets or facilities at the hands of terrorists or criminals. Inherent in those physical threats is the motivation to cause bodily injury or property damage (terrorists), to profit (drug trafficking, cargo theft), or take revenge (insiders). Lastly, and developing most recently, are threats that result from the increasingly sophisticated abilities of hackers, criminals, and terrorists to exploit information system vulnerabilities. The same technologies that enable companies to increase efficiency and reduce overhead costs introduce new vulnerabilities that can be exploited by entities from this latter threat source. In analyzing the threats to the transportation information infrastructure, the IIG provides the following summary of findings:

- **The transportation industry focuses on physical threats.** From a security perspective, the primary focus of the transportation industry continues to center on the impact of physical threats to the infrastructure. As in the past, protection of critical hubs (airports, seaports, etc.) and transportation vehicles (trains, aircraft, trucks, etc.) from natural disaster, theft, or terrorist action remains the most prevalent security concern in the transportation industry. However, many companies are changing their approach to physical threats by automating key components of their physical security strategy to protect company assets and promote overall public safety. Several representatives contributing to this study reported a near complete reliance on information technology to conduct daily business and carry out their basic public safety missions.
- **The potential for insider threats to transportation companies is increasing.** Transportation companies that participated in the workshops view insiders as the greatest threat to information security. The insider threat has historically been disgruntled employees exploiting their knowledge of a company to gain unauthorized access into sensitive corporate systems. The motive is often revenge or blackmail. However, industry representatives noted that their definition of an insider has expanded to include employees of a business partner of the company who is not under their immediate control, such as a subcontractor, supplier, or customer. As globalization, consolidation, corporate downsizing, and intermodalism increase, transportation companies will increasingly turn to outsourcing and strategic alliances to meet their business needs. This change in how they conduct business is likely to expose them to additional insider threats.

- **There is a varying degree of awareness about information system threats.** Feedback from workshop participants indicates that information technology professionals are generally more aware of cyber and electronic threats than employees with business operations responsibilities. IT professionals who participated in the NSTAC's efforts reported an awareness of deliberate electronic intrusions through their corporate Internet connections, unauthorized access to company networks, and "insider threats" posed by current and former employees. The level of awareness about information system threat also varies in inverse proportion to management level. Awareness of information security concerns tends to decrease as the level of management responsibility increases (see Figure 21). For operations professionals, the trend is reversed. Workshop participants reported that personnel with senior management responsibilities in both the IT and operations fields tended to approach information system threat awareness in the context of the potential for a financial impact to the company.

**Figure 21.**  
**Awareness of Information Security Threats vs. Management Level**



Through its outreach efforts, the IIG also discussed existing deterrents to the threats posed to the transportation information infrastructure. These deterrents, which are discussed in Section 4.3 of this study, involve efforts to limit the number of threats to a system by increasing the penalties for committing an act. (e.g., law enforcement, criminal laws and sentencing guidelines, education and awareness).

## **5.2 Vulnerabilities**

Vulnerabilities are any flaws or weaknesses that could be exploited by threat agents. Like other complex information systems and networks, vulnerabilities to the transportation information infrastructure range from highly technical problems such as software or hardware deficiencies to inconsistent corporate policies and procedures for detecting and responding to network intrusions. In studying the transportation information infrastructure, a general theme emerged: *the industry is under enormous pressure to meet growing customer demands in the highly competitive global economy*. Like other industries, the transportation industry is increasingly relying on the benefits of information technology to meet the needs of a new business environment. This reliance, while beneficial from an economic and competitiveness perspective, also introduces new vulnerabilities into the transportation information infrastructure. Specifically, the IIG provides the following summary of findings:

- **The growing prevalence of intermodalism increases vulnerabilities to the transportation information infrastructure.** In a growing global economy, both cargo and passengers are more likely to move from one mode of transportation to another numerous times before reaching a final destination. To facilitate this intermodal movement, transportation companies are increasingly dependent on one another for normal operations and must share passenger, cargo, and carrier information for efficient transportation. Intermodalism also increases the importance of transportation hubs, such as airports and shipping ports. As intermodal traffic through these hubs continues to grow, they are likely to become critical choke-points for cargo and passenger facilitation. Questions regarding what entity is responsible for information security are likely to emerge. For example, hubs are often not solely responsible for ensuring the security of information as a transfer from one mode to another occurs. As consolidation increases in the industry, some companies that own the hub and all modes of transportation are able to maintain responsibility throughout the transport of cargo. In other cases, where passengers or goods are transferred from one company to another, the physical and information security responsibilities are less clear and may require customer or third party involvement.
- **The demand for “open” information systems is exposing the industry to new risks.** Perhaps the most prevalent development in the transportation infrastructure concerning cyber threats is the movement by all modes of transportation from closed, proprietary networks to open, interconnected networks. For many transportation companies, the value they provide to a customer includes not just transportation services, but value-added information about the transportation transaction (e.g., online reservation information, cargo tracking data). Business customers rely increasingly on just-in-time inventories and advanced supply chain management techniques for profitability, further compounding the demands on the information system capabilities of the transportation industry. In many cases, this business

necessity has forced transportation carriers to open their networks to customers and suppliers, allowing free access to previously closed systems for the sake of improved information flow and operating efficiencies. Information security executives and practitioners in the transportation industry indicated that they perceived a lack of existing security tools to facilitate optimal and safe operation of open systems, as well as an inability of security tools to adapt as these systems continue to evolve.

- **All modes are developing a reliance on GPS.** As discussed in Section 3.0 of this report, GPS has been identified as a major enabling technology for automated vehicle control and navigation among all modes in the transportation infrastructure. As companies continue to develop business strategies that rely on GPS applications for cargo tracking, vehicle navigation, and flight systems, the potential impact from a loss of GPS service becomes more significant. According to law enforcement officials who participated in the subgroups outreach activities, the threat of hackers altering the trajectory of GPS satellites is exaggerated, and most companies expressed the ability to continue operations without GPS service in the near term. However, it is expected that as dependence on GPS increases and as more transportation carriers rely upon GPS transponders for their primary means of navigation, the potential consequences of a GPS failure will continue to grow.
- **There is a strong reliance in the transportation infrastructure on other critical infrastructures to support information systems.** Although many transportation companies utilize robust private networks, the electric power and telecommunications infrastructures were identified as essential to support their most critical business functions. A primary concern is a large-scale outage in the Nation's public telecommunications network, the Internet, or the power grid that would dramatically affect the ability of the transportation infrastructure to continue operations. Such disruptions would limit the ability of companies to communicate with their assets, critical facilities, and each other. Several industry representatives also noted that transportation companies are increasingly reliant on educational institutions to produce professionals with the capability to manage and protect their information systems; but these institutions are not specifically identified as an infrastructure.

### **5.3 Protection Measures**

As in other industries, transportation companies have numerous motives for developing risk mitigation strategies and protection measures. As the NSTAC concluded in prior risk assessments of the electric power and financial services infrastructures and the public network, there are strong financial incentives to protect information systems from destruction, degradation, or exploitation. Those actions, if successful, might adversely affect consumer confidence. In addition to these sensitivities, the transportation infrastructure is also concerned with high profile public safety concerns. In short, human lives are at risk when the transportation

infrastructure is threatened. In considering the risk mitigation strategies employed in the transportation industry, the IIG provides the following summary of findings:

- **Information systems are an important component of business continuity plans.** Transportation companies more often consider the need to protect and secure information systems when developing business continuity plans. As information systems are more essential in support of critical business operations, transportation companies have incorporated network redundancy architectures and information back-up capabilities and procedures into these plans to avoid single points of failure and to ensure protection of their vital systems and data centers. This effort to protect information systems is enhanced by recent industry efforts to develop responses to potential Year 2000 (Y2K) problems. Companies in every mode of transportation reported increased information security awareness and a revisiting of contingency plans as a result of their Y2K efforts.
- **There are varied information security strategies to mitigate risk.** Many transportation companies have addressed the inherent risks associated with open systems through the implementation of rigid information security policies that involve traditional risk management practices. Transportation companies tend to approach information security strategies from a reactive posture; therefore, they develop overall security policies and procedures on an ad hoc basis. Efforts to develop those policies and procedures are further complicated when transportation companies formulate their information security strategies to meet specific customer requirements. Included among the methods employed by companies to manage information system risks are daily backups of critical data, network security banners, and the use of vulnerability testing to expose flaws in information security configurations. The use of encryption for the transmittal of sensitive data domestically and globally, as permitted, is also common. Yet transportation companies, much like many other global enterprises with international operations, reported a preference for rescinding current U.S. restrictions on the international use of strong encryption. The rationale is that companies would like to maintain the same degree of confidence regarding the security and integrity of sensitive business data sent abroad that they do for information sent within U.S. borders.
- **Quantifying the cost of risk can help define the importance of information security.** Both the financial concerns and the critical public safety function of the transportation infrastructure have compelled industry executives responsible for information security to attempt to quantify the cost of risk management. By identifying revenue increases or cost savings resulting from information security, it is far easier to justify and rationalize a greater security investment. Transportation companies that allocate more funds to safeguarding their information systems have quantified the risk of information security breaches as projected revenue losses,

potential loss of business, expenditures associated with remediation, and higher insurance premiums. Companies that have been able to justify increased information technology security measures have done so by presenting cost impact analysis to senior management. The airline industry, in particular, has been successful in quantifying the costs of information security measures in terms of lower insurance rates paid by individual companies that ensure a certain level of information security.

#### **5.4 Other Infrastructure Protection Issues**

Unlike the prior NSTAC risk assessments of the electric power and financial services infrastructures, this study concluded after the signing of Presidential Decision Directive 63. The directive emphasizes the importance of building a public-private partnership that is “genuine, mutual, and cooperative” to eliminate vulnerabilities to critical infrastructures. In particular, there were significant outreach discussions at the second NSTAC conference regarding PDD-63 and other Federal infrastructure assurance initiatives. With these initiatives in mind, the IIG provides the following summary of findings:

- **There is no centralized point for gathering and sharing information about threats, vulnerabilities, and best practices.** Transportation companies gather information security threats, vulnerabilities, and best practices through informal interactions with a variety of unrelated sources. Those sources include trade groups, conferences, information security vendors, independent research organizations, local law enforcement, the Internet, and regional corporate professional organizations. Industry associations and competitors are also cited as potential sources for information security data, but the value of the information provided by these sources varies by mode. Further, although industry associations are aware of the information sharing provisions of PDD-63, few workshop participants from individual companies seemed knowledgeable about Government-sponsored critical infrastructure initiatives. As to the information sharing provisions included in PDD-63, transportation companies have an interest in sharing information with the Government regarding their information system vulnerabilities but are sensitive to potential anti-trust and industry competition difficulties. The companies also expressed interest in receiving “best practices” information from other sectors regarding information security methods and information sharing successes. Although the present level of information reporting to regulatory agencies is considered appropriate and not overly burdensome, few transportation companies recounted ever having received information system threat or vulnerability data from Government sources.
- **There are significant R&D concerns related to infrastructure assurance.** Industry representatives expressed the opinion that the Federal Government should fund R&D efforts that can improve the information security of the transportation

information infrastructure as a whole. As previously stated, industry representatives emphasized the need for a process by which information security products can be independently assessed and rated. Individual companies are often too small or do not have the expertise to conduct such assessments in house and would prefer collaborative efforts to pool R&D resources. Transportation industry representatives also stressed that the infrastructure would benefit from an ongoing, proactive R&D effort to develop new technologies to counter information security vulnerabilities.

- **There is a requirement for increased education, training, and awareness in the transportation industry.** As stated above, transportation executives have difficulty identifying and hiring information security personnel with the appropriate levels of training and professional certification. Transportation companies support Government initiatives to form partnerships with universities to develop undergraduate and graduate programs focused on educating and training the next generation of information security professionals. It is also clear that the transportation infrastructure would benefit from further outreach efforts related to cyber threats, infrastructure vulnerabilities, and the risks associated with increased reliance on information systems. Although the Transportation Risk Assessment Subgroup identified many qualified information security professionals with a solid understanding of information system vulnerabilities and infrastructure dependencies, they were not necessarily representative of the industry as a whole. In general, these representatives were from the largest companies with sufficient resources to invest in security. In addition, representatives from all transportation modes at both NSTAC workshops identified the need for additional fora to further increase the industry's awareness of threats and vulnerabilities throughout the infrastructure.

## **6.0 CONCLUSIONS**

Based on the findings from the NSTAC Transportation Information Infrastructure Risk Assessment workshops and other transportation industry outreach activities, the IIG came to six high-level conclusions about risks to the transportation infrastructure:

**Conclusion 1: The transportation industry is increasingly reliant on IT and public networks.**

The efficiencies and cost savings realized by the employment of information technology capabilities will cause transportation companies in each mode to open their information systems. This trend will occur as a result of growing customer demand but will likely lead to an increase in information system vulnerabilities. Although individual companies and modes have traditionally utilized private and proprietary systems to carry a limited amount of data, business pressures are increasing the level of information system risk.

**Conclusion 2: Although a nationwide disruption of the transportation infrastructure is unlikely, even a local or regional disruption could have a significant impact.**

No single system or critical point of failure is apparent in the transportation infrastructure that could cause disruption on a national scale if destroyed or degraded. In the past, modes tended to operate independently of one another and infrequently shared information system access. The sheer diversity and number of alternative transportation modes provide the United States with a highly redundant transportation system that appears immune to a nationwide disruption. Nonetheless, a disruption of the transportation information infrastructure, on even a regional or local scale, could have the potential for widespread economic or national security impacts.

**Conclusion 3: Business pressures and widespread utilization of IT make large-scale, multimodal disruptions more likely in the future.**

Factors such as intermodalism, globalization, consolidation, and an increasing reliance on advanced information technologies are changing the face of the transportation industry. As transportation companies react to market pressures and deregulation, they are using critical transfer points and common information systems more frequently. The result is a more interconnected and interdependent transportation industry that relies on information technology to complete its daily business functions. All of the factors cited above will make it more likely that the transportation industry's dependencies on telecommunications, the Internet, Web-based applications, and other advanced IT applications like GPS will grow. As such, it becomes more probable that an information system failure could result in a large-scale disruption of multiple modes of the transportation infrastructure.



**Conclusion 4: There is a need for a broad-based infrastructure assurance awareness program to assist all modes of transportation.**

As noted in the findings, there are varying degrees of awareness of security risks and issues across the various modes of transportation. Awareness of information system risk should be raised among both individual companies and the transportation infrastructure as a whole. A broad-based approach that includes the exchange of threat and vulnerabilities information would help to bring all modes of the transportation infrastructure up to a common level of awareness and would greatly facilitate infrastructure assurance efforts. Moreover, a broad-based program would be particularly beneficial because the transportation infrastructure consists of numerous modes that are, in many ways, several infrastructures unto themselves.

**Conclusion 5: The transportation industry could leverage ongoing R&D initiatives to improve the security of the transportation information infrastructure.**

Transportation industry officials participating in the workshops emphasized the importance of R&D to improve the security of the transportation information infrastructure. The transportation industry would benefit from participating in ongoing Federal efforts to direct approximately \$500 million in R&D funding to develop next-generation intrusion detection and other information protection technologies. The transportation industry would also benefit from the development of a standard information security rating system that includes verification of information security solutions by third parties.

**Conclusion 6: There is a need for closer coordination between the transportation industry and other critical infrastructures.**

There are strong interdependencies between the transportation infrastructure and other critical infrastructures. In particular, very strong linkages exist between the transportation, information and communications, and electric power infrastructures. Therefore, it would be mutually beneficial for all three infrastructures to share information on emerging threats and vulnerabilities, industry trends, and information security best practices and standards.

## **7.0 RECOMMENDATIONS**

### **7.1 NSTAC Recommendations to the President**

#### ***7.1.1 Department of Transportation PDD-63 Efforts***

Recommend that the President continue support for the efforts of the Department of Transportation to promote outreach and awareness within the transportation infrastructure as expressed in PDD-63. Specifically, recommend that the President and the Administration ensure support for the following activities:

- timely dissemination of Government information on physical and cyber threats to the transportation industry,
- Government research and development programs to design infrastructure assurance tools and techniques to counter emerging cyber threats to the transportation information infrastructure,
- joint industry/Government efforts to examine emerging industry-wide vulnerabilities such as those related to GPS, and
- future DOT conferences to stimulate intermodal and, where appropriate, interinfrastructure information exchange on threats, vulnerabilities, and best practices.

**APPENDIX A**

**TRANSPORTATION RISK ASSESSMENT SUBGROUP MEMBERS**

**TRANSPORTATION RISK ASSESSMENT SUBGROUP MEMBERS**

CSC	Mr. Richard Swanson, Chair
NTA	Mr. Bob Burns
CSC	Mr. Guy Copeland
DOT	Mr. Tim Custer
Unisys	Ms. Mary Dale
DOT	Mr. Tom Falvey
GTE	Ms. Ernie Gormsen
CSC	Ms. Deborah Jacobs
TRW	Mr. Bob Lentz
U S WEST	Mr. Jon Lofstedt
Boeing	Mr. Bob Steele
GTE	Mr. Lowell Thomas
Raytheon/E-Systems	Mr. Bob Tolhurst
Unisys	Mr. Fred Tompkins
Lockheed Martin	Mr. Bruce Wallachy
Unisys	Dr. Dan Wiener
EDS	Mr. Jim Williams

**APPENDIX B**  
**ACRONYM LIST**

**Acronym List**

AAR	Association of American Railroads
ABS	Automatic Block Signals
ADSB	Automatic Dependent Surveillance Broadcast
AEI	Automatic Equipment Identification
AOPA	Aircraft Owners and Pilots Association
ATA	Air Transport Association
ATC	Air Traffic Control
ATC	Automatic Train Control
ATV	Automatic Train Supervision
BART	Bay Area Rapid Transit
BCI	Border Coordination Initiative
BESTEA	Building Efficiency through Surface Transportation and Equity Act
CAD	Computer-Aided Dispatch
CBTC	Communications Based Train Control
CFIT	Controlled Flight Into Terrain
CHCP	Cargo Handling Cooperative Program
CISP	Criminal Intelligence Support Program
CNS	Communications, Navigation, and Surveillance
COTS	Commercial Off-The-Shelf
CRAF	Civil Reserve Air Fleet
CTC	Centralized Traffic Control
DGPS	Differential Global Positioning System
DOD	Department of Defense
DOT	U.S. Department of Transportation
EC	Electronic Commerce
ECU	Electronic Control Units
EDI	Electronic Data Interface
EFT	Electronic Funds Transfer
EGPWS	Enhanced Ground Proximity Warning System
FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FBI	Federal Bureau of Investigation
FedEx	Federal Express
FRA	Federal Railroad Administration
GOTS	Government Off-The-Shelf
GPS	Global Positioning Satellite
IIG	Information Infrastructure Group
ISTEA	Intermodal Surface Transportation Efficiency Act
IT	Information Technology
ITI	Intelligent Transportation Infrastructure
ITS	Intelligent Transport Systems

## ***President's National Security Telecommunications Advisory Committee***

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JIT	Just-In-Time
LTL	Less-Than-Truckload
MARAD	Maritime Administration
NAFTA	North American Free Trade Agreement
NAS	National Airspace System
NCSC	National Cargo Security Council
NDS	National Distress System
NEXTEA	National Economics Crossroads Transportation Act
NS/EP	National Security and Emergency Preparedness
NSA	National Security Agency
NSIE	Network Security Information Exchanges
NSTAC	National Security Telecommunications Advisory Committee
NTSB	National Transportation Safety Board
NYC	New York City
OCC	Operations Control Center
ONEDOT	One Department of Transportation
PC	Personal Computer
PCCIP	President's Commission on Critical Infrastructure Protection
PDD-63	Presidential Decision Directive 63
PPS	Precise Positioning Service
PTC	Positive Train Control
R&D	Research and Development
SABRE	Semi-Automated Business Research Environment
SBC	Single Board Computers
SCADA	Supervisory Control and Data System
SPS	Standard Positioning Service
SRCS	Short Range Communications System
STATIS	Subway Train and Traffic Information System
TCAS	Traffic-Alert and Collision Avoidance System
TCP/IP	Transmission Control Protocol/Internet Protocol
TEA-21	Transportation Equity Act for the 21st Century
TEU	Twenty-Foot Equivalent Units
TL	Truckload
TRAIN II	Tele Rail Automated Information Network
UP	Union Pacific
UPS	United Parcel Service
USCG	United States Coast Guard
VHF-FM	Very High Frequency-Frequency Modulation
VOCC	Vessel Operating Common Carriers
WAAS	Wide Area Augmentation System
WIM	Weigh-in-Motion
Y2K	Year 2000